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Full Name of Author — Nom complet de l'auteur
PRISCILLA WANJIRU KARIUKI

Date of Birth — Date de naissance
17th Nov 1947

Country of Birth — Lieu de naissance
KENYA

Permanent Address — Résidence fixe
P.O. BOX 23067, LOWER KABETE, NAIROBI, KENYA

Title of Thesis — Titre de la thèse
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Name of Supervisor — Nom du directeur de thèse
PROF. R.S. MACARTHUR

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TRAINING AND TRANSFER OF CLASS INCLUSION IN YOUNG CHILDREN

by

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A THESIS
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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Training and Transfer of Class Inclusion in Young Children".

submitted by Priscilla Wanjiru Kariuki

in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Educational Psychology.

R.S. MacArthur
Supervisor

W H O Schmidt

Jay Bisbee

Carl Urion

Philip E. Vernon
External Examiner

Date 8 October, 1980

ABSTRACT

The main purposes of this study were: (1) to investigate the effectiveness of training methods and materials in the acquisition of the class inclusion concept among five- and six-year old kindergarten and grade one children; (2) to examine the nature of young children's understanding, retention, and transfer of this logical ability; and (3) to examine the results in light of a cross-cultural framework which may have potential in interpreting responses from children in a different culture, socioeconomic level or simply a different setting.

Piaget's theory indicates that the logic of classes and hierarchies is incomprehensible to preoperational children until they have the ability to use the logical quantifiers "all" and "some". Subjects in this study were required to have reached the appropriate stage of "all" and "some" in a pretest designed for that purpose. A second pretest using Piaget's classic class inclusion experiment with wooden beads was administered to assess subjects' level of understanding class inclusion. Subjects were required to show lack of class inclusion understanding via the second pretest, in order to qualify for training. These two pretests were used to select sixty subjects who understood "all" and "some" but did not understand class inclusion. These subjects were then randomly assigned to six treatment groups of ten subjects each, one of which was the control group.

Five training conditions were designed, which combined methods and materials thus: self-discovery methods and concrete materials; self-

discovery methods and pictorial materials; tutorial methods and concrete materials; tutorial methods and pictorial materials; and verbal methods and materials. The control group received no training. Treatment groups received 10 to 30 minutes training designed to help them comprehend that when subclasses A and A' additively compose the superordinate class B, then $B > A$ and $B - A' = A$. Four posttests from Immediate Transfer to One Month Transfer were administered at approximate ten-day intervals after training.

One-Way Analysis of Variance tests were carried out and significant F ratios obtained between treatment groups and the control group. Multiple comparisons of mean scores were carried out using the studentized range statistic - Newman-Keuls method, and statistically significant Q values obtained between each of the treatment groups and the control group.

When each posttest was considered separately as a dependent variable, there were no statistically significant differences among the means of the treatment groups (materials), except that all treatment groups were consistently superior to the control group. Similarly, there were no statistically significant differences among the treatment groups (methods).

But, when all eight posttests were considered together as dependent variables, there were consistent differences among the treatment groups (materials) as the means for the groups were ranked by the eight posttests, even when the control group was omitted. Specifically, concrete materials were consistently superior to pictorial materials. Similarly, tutorial methods were consistently superior to self-discovery methods.

The main findings of this study showed that the training program was effective in inducing class inclusion among five- and six-year old middle-class, urban, Alberta children, when the appropriate training techniques were employed and when the appropriate stage of understanding "all" and "some" had been reached.

A significant finding of this study was the fact that the same conclusions were reached when scores with and without justification were used in the analyses. This finding has important implications for research in cross-cultural settings in which inferences based on the verbalization of subjects' responses have led to biased results and erroneous conclusions on lack of competence for cognitive reasoning.

These findings imply that the acquisition of class inclusion can be accelerated if the appropriate conditions are present. The use of a variety of materials and diverse teaching techniques in the classroom setting are suggested. For the planned replication study in Kenya (Phase II) less emphasis will be laid on the verbal justification criterion, but the use of concrete and familiar materials will be emphasized.

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CHAPTER ONE

GENERAL PROBLEM

In recent years, psychologists and educators have shown a growing interest in the nature of the processes which characterize children's responses to class inclusion problems. This trend is illustrated by the considerable research effort on the problems that children encounter in responding to class inclusion questions (e.g. Jennings, 1970; Kalil, Youssef and Lerner, 1974; Tatarsky, 1974; Wohlwill, 1968; Ahr and Youniss, 1970; Markman, 1973; Winer, 1974; Winer and Kronberg, 1974). In addition, several studies have found that performance on class inclusion tasks may improve when training procedures are employed to overcome initially incorrect responses (e.g. Ahr and Youniss, 1970; Brainerd, 1974; Kohnstamm, 1967; Sheppard, 1973).

The purpose of the present study was to investigate the effectiveness of training methods and materials in the acquisition of the class inclusion concept among five- and six-year old kindergarten and grade one children. A second concern of the study was to examine the nature of young children's understanding, retention and transfer of this logical ability. A further interest of the study was to examine the results in light of a cross-cultural framework which may have potential in interpreting responses from children in a different culture, socioeconomic level or simply a different setting. This latter objective was made with the underlying assumption that classifying is a universal phenomenon and a way of life for all cultures, since ways of classifying and categorizing are built into the language and daily lives of people. However, there might be differences with regards to the nature of the materials classified, the rate and style of classifying, and the dimensions used in the classification system.

Class inclusion was defined as the understanding that a total class (animals) must be bigger than one of its constituent subclasses (cows). When a child acquires this understanding, he is capable of realizing that a superordinate class such as animals contains subclasses such as cows and goats. According to Piaget (1952), when children recognize this hierarchical nature of classes and are able to combine subclasses into their respective superordinate classes, then they reflect mastery and comprehension of the class inclusion problem. Thus, the understanding of the concept of class inclusion is an important aspect of logical reasoning abilities.

According to Piagetian theory, the importance of the class inclusion concept is the fact that its comprehension is the decisive test of whether or not a child has reached the concrete operational stage in classificatory skills (Inhelder and Piaget, 1964). While estimates vary of the age at which children are able to understand class inclusion, it is typically not characteristic of children's cognitive processes until they are at least seven or eight years old (Piaget and Szeminska, 1941; Piaget, 1952; 1958; Inhelder and Piaget, 1964; Klahr and Wallace, 1972).

When young children are questioned about the relationship between a superordinate class and its subclasses, they typically give a response based on the majority subclass. The failure to answer the class inclusion question correctly may be due either to the absence of reasoning skills or to non-logical factors. According to Piaget, young children fail on these problems because their cognitive structures lack the operational characteristic of reversibility required for simultaneous comparison of part and whole. That is, the young child cannot decompose the whole to obtain the part, and at the same time reverse this operation to recompose the whole for comparison with the part. He is instead limited to comparing one part with another when presented with inclusion problems. The child who experiences difficulty with the class inclusion relation is also said to be lacking in the logical operations of addition and subtraction leading to the inaccurate use of the logical quantifiers "all" and "some". Inhelder and Piaget (1964) argue that errors in handling "all" and "some" lead to errors with class inclusion since these two factors are indissolubly linked. The mastery of class inclusion necessitates a firm grasp of the distinction between "all" and "some".

A typical class inclusion task involves the presentation of two subclasses of items (e.g. 18 brown beads A and 2 white beads A' which both belong to one superordinate class of wooden beads B). After the child has examined the collection of items, he is asked whether there are more brown beads or more wooden ones. The child who answers "more wooden beads" is assumed to be able to understand class inclusion. The child who answers "more brown beads since there are hardly any white", is assumed to be unable to understand class inclusion, in spite of the fact that he may have agreed at first that all the beads are wooden and that not all of them are brown. Piaget's explanation is that young children cannot hold in their heads simultaneously the ideas that:

(i) wooden beads consist of brown and white ones,

(ii) wooden beads are more than either brown or white ones each by the amount of the other, i.e.

a. wooden beads = brown beads + white beads: $B=A+A'$

b. brown beads = wooden beads - white beads: $A=B-A'$

c. white beads = wooden beads - brown beads: $A'=B-A$

By separating "wooden" beads into "brown" and "white", the child makes "wooden" disappear from the structure as a whole because he cannot think back to its wholeness (wooden) and simultaneously think of it as consisting of two parts (brown and white).

Piaget's claim that this is inevitable seems open to question, for there is evidence that the performance of young children may improve when certain aspects of the inclusion task are varied. For example, when changes are made to characteristics of the array (Tatarsky, 1974; Wohlwill, 1968) or when changes are made to the form of the inclusion question (Kalil, Youssef and Lerner, 1974; Markman, 1973; Winer, 1974) or when changes are made to the method of task presentation (Jennings, 1970; Winer and Kronberg, 1974; McGarrigle et al, 1978; Siegel et al, 1978).

Recent studies have also found that performance on class inclusion may improve when appropriate training procedures are employed (Ahr and Youniss, 1970; Aldrich, 1970; Sheppard, 1973; Robinson, 1975; Wilkinson, 1976, Brainerd, 1974). These studies have not, however, established conclusively the processes that young children go through as they acquire the ability to grasp the inclusive relation of classes. The evidence concerning the kinds of materials used in the training and testing (Kohnstamm, 1967; Morf, 1959; Wohlwill, 1968) has been generally inconsistent. Similarly, the evidence concerning the effectiveness of different training methods has been contradictory. Some investigators have emphasized the facilitative effects of feedback during training (Brainerd, 1974; Kohnstamm, 1967; Hatano and Kuhara, 1972; Siegel et al, 1978) while others (Inhelder and Piaget, 1964; Morf, 1959; Inhelder and Sinclair, 1969; Inhelder, Sinclair and Bovet, 1974) have indicated that the child should be guided to discover for himself the correct responses without necessarily being told whether he is right or wrong in his performance.

Since class inclusion is viewed as so important a step in the sequence of development of reasoning skills, psychologists and educators have continued to make attempts to devise means for accelerating its development through intervention procedures.

The primary objective of the present study was to explore the effectiveness of training methods (self-discovery and tutorial) and training materials (concrete, pictorial, and verbal) in the acquisition of class inclusion concept among kindergarten and grade one children. It was in general assumed that five- and six-year old children possess the underlying competence or potential to learn class inclusion concepts. Hence, a further objective of the study was to examine the nature of young children's competence through their performance, understanding, retention and transfer of this reasoning skill. It is expected that the results of this investigation will be useful to researchers interested in exploring the classificatory abilities of children from different cultures, environments or settings. It is also expected that the findings of this study will provide additional information on ways that can be used to train five- and six-year old children to improve their performance while dealing with the important aspects of classes and their relationships.

CHAPTER TWO

RELATED THEORY AND RESEARCH

The impetus for a great deal of the research reported in this chapter originated with the extensive investigations of Piaget and his co-workers (1941; 1952, 1958; 1964). Since that time, there have been numerous studies by other investigators in which attempts have been made to validate Piaget's original findings, replicate his experiments, examine the ages and stages when the quantification of class inclusion concepts develop, and more recently attempts have been made to induce this concept experimentally.

Piaget's Theory and Research

The class inclusion task originated with Piaget (1941) in his study of the concept of number. The problem was systematically put before children by Piaget and Szeminska (1941) in their study of the development of the child's conception of number. Further extensive investigations of the class inclusion problem by Piaget (1952) and Inhelder and Piaget (1964) followed. A typical example of the class inclusion task involved a presentation of a box of wooden beads, most of which were brown and only two were white to children five to eight years of age. The critical question posed to the child was: "Are there more wooden beads or more brown ones?" Piaget and his colleagues found that the answer the children gave was a firm, "more brown beads". After a careful analysis of the children's responses, it was clear to Piaget that the children did not regard the larger part as more numerous than the whole, but that they simply did not see the whole any more after having paid attention to the parts. As a result they took the comparison between part and whole asked for by the question to mean a comparison of both parts. This problem was of particular interest to Piaget because of the fact that most children seemed incapable of comparing a whole and a part of the whole before the age of seven to eight years.

Several variations of the problem were made in the series of experiments that followed. One of the first variations was to ask the child which of two necklaces would be longer, one made with the brown beads or one made with the wooden beads. A variety of materials was also employed. The whole could be formed by blue beads, most of which were square and only two or three were round. The problem was also posed using a collection of flowers containing 20 poppies and two or three bluebells. The child was then asked which would be the bigger bunch, one made with all the flowers or one made with all the poppies. Piaget (1952) reported that these variations did not help to bring about any change in the results.

Inhelder and Piaget (1964) took this problem further and investigated the necessary conditions for class inclusion to develop. In one of those studies, the authors assessed children's understanding of the quantifiers "all" and "some". The subjects were 86 children between five- and nine-years of age. The subjects were presented with 8 to 21 red squares and blue circles and asked these questions:

CB : Are all the circles blue?

RS : Are all the red ones squares?

BC : Are all the blue ones circles?

SR : Are all the squares red?

(Inhelder and Piaget, 1964, p.63)

The results indicated that some of the younger children were unable to think of a single element possessing two properties at once. That is, the intensive and extensive properties of classes. Intensive properties are properties which are common to the members of the given class and those of other classes to which it belongs: properties which are specific to the members of the given class, and which differentiate them from members of other classes. Extensive properties are those which deal with part-whole relations of class membership and inclusion (e.g. "all" and "some"). Inhelder and Piaget (1964) found that children had difficulties in making this differentiation and remarked that ".... if children have difficulty with class inclusion it is because they find it difficult to adjust their use of "all" and "some" to the intensive properties of the elements to which these qualifiers are being applied." (p.59). The authors also indicated that the child has no difficulty in appreciating that the class of circles consists of two subclasses, the red ones and the blue ones. But once the child separates the subclass of blue circles from the remainder, whether in reality or in his mind, the class of circles ceases to exist for him.

Piaget (1952) describes three stages that were observable during the above investigations. During Stage I, children do not understand that class A (brown beads) is contained in class B (wooden beads) and as a result they always say that A is larger than B. During Stage II, children's performance is better than in Stage I but they continue to maintain that A is larger than B. However, they are aware that A is subordinate to B and occasionally they discover by trial and error that B is larger than A. When children get to Stage III, they are aware that A is included in B and they realize that this fact logically implies that B must always be larger than A no matter how large A is. Children at the third stage are able to simultaneously take into consideration both kinds of classes and the superordinate class.

The position adopted by Piaget and Inhelder (1969) is still the dominant theoretical view of class inclusion and its interpretation:

> If, for example, in a group B of twelve flowers within which there is a subgroup A of six primroses, you ask the child to show first the flowers B and next the primroses A, he responds correctly, because he can designate the whole B and the part A. However, if you ask him, "Are there more flowers or more primroses?" he is unable to respond according to the inclusion $A < B$ because if he thinks of the part A, the whole B ceases to be conserved as a unit, and the part A is henceforth comparable only to its complementary A'. He may reply, therefore, "the same" or, if there is a clear majority of primroses in the set, he may say that there are more primroses. The understanding of the relative sizes of an included class to the entire class is achieved at about eight and marks the achievement of a genuine operatory classification. (Piaget and Inhelder, 1969, p.103).

Thus according to Piaget and Inhelder, failure on the class inclusion task comes from the child's inability to think of the whole B while thinking of one of its parts A. It is only later that the child develops the requisite representations and processing capacity such that the whole B continues to exist even while its components A and A' are separated in thought. (Inhelder and Piaget, 1964).

The prominence accorded to class inclusion by Piaget and his colleagues (1952; 1964) indicates that it represents the manifestation of the stage of concrete operations. Inhelder and Piaget (1964) believe that the class inclusion operation is a measure of classificatory skill and an indicator of the onset of concrete operational intelligence. They view the understanding of class inclusion as essential to the conception of number. Furthermore, the empirical results obtained by presenting children with class inclusion tasks afford striking, but typical examples of complete changes in performance with development.

The above investigations indicate that preoperational children are incapable of combining two subordinate classes to obtain the superordinate class. At this stage children are also incapable of decomposing the superordinate class to obtain the two subordinate classes. When this same problem is administered to concrete operational children, Piaget says that they are able to solve it without many problems. According to Piaget, younger children fail on the class inclusion problem because their cognitive structures lack the operational characteristic of reversibility required for simultaneous comparison of part and whole. That is, the young child cannot decompose the whole to obtain the part, and at the same time reverse this operation to recompose the whole for comparison with the part, so that the whole remains invariant whatever the relationship between the whole and the part. Thus in Piaget's view, the young preoperational child cannot make the simultaneous comparison of part with whole and he is instead limited to comparing one part with another when presented with inclusion problems.

Piaget's Position on Learning

It is implicit in Piaget's developmental theory that a child must be ready in order to learn. A readiness approach emphasizes that children cannot learn something until maturation gives them the proper equipment. Most commentaries on the educational implications of Piaget's theory stress children's readiness to learn as a prime criterion in deciding when to introduce certain subjects. Piaget himself has firm convictions on the role of learning and development and according to him "learning is subordinated to development." Children's ability to learn any of Piaget's cognitive concepts is always "subject to the general constraints of the current developmental stage" (1970b, p.713). Piaget believes that children's ability to learn operational concepts "vary very significantly as a function of the initial cognitive levels of the children" (1970b, p.715). As a result, Piaget asserts that, "teaching children concepts that they have not already acquired in their spontaneous development .... is completely useless" (1970d, p.30).

For Piaget, children who are below the stage at which a given concept normally develops cannot be taught concepts from the next stage of cognitive development. Thus for him, no amount of training will cause truly preoperational children to acquire operational concepts. Piaget (1964) has discussed three criteria as vital in ascertaining whether a researcher has ".... succeeded in teaching operational structures" (p.17). The first is the durability of learning. Piaget asks ".... what remains two weeks or a month later?" (1967, p.332). The second criterion concerns the vital issue of generalization or transfer to related cognitive strategies. Can this knowledge be transferred to a new problem? The third criterion is best described in Piaget's own words:

> In the case of each learning experience what was the operational level of the subject before the experience and what more complex structures has this subject succeeded in learning? .... We must look at each specific learning experience from the point of view

> of the spontaneous operations which were present at the outset and the operational level which has been achieved after the learning experience. (Piaget, 1964).

If these criteria can be met and the questions positively answered, then Piaget would say that the learning experience has had some effect on cognitive growth. This does not however, mean that Piaget believes nothing can be done to expedite the development of operational structures. His idea seems to be that:

> Acceleration of learning is possible if the more complex structure is based on simpler structures. That is, when there is a natural relationship and development of structures, and not simply on external reinforcement. (Piaget, 1964, p.17).

This implies that attempts at exposing subjects to situations involving more complex structures than at present exist in their repertoire demands a careful breakdown and selection of simpler structures which are capable of being assimilated. Piaget's opinion is that development cannot be reduced to a series of bits of learning and ".... the notion of competence has to be introduced as a precondition for any learning to take place." (Piaget, 1974).

The following studies are representative of a great number of studies dealing with the acquisition of class inclusion by young children.

Class Inclusion Studies

Class inclusion, one of the levels of thinking described in Piaget's theory of intelligence is an important milestone in the intellectual development of the child at the operational level. Piaget considers the quantification of inclusion relations to be the best criterion for diagnosing the presence or absence of concrete logical operations in classification.

In the past decade, class inclusion has inspired a steady stream of studies dedicated mainly to validating the developmental changes that Piaget discusses. A fair amount of work relating to class inclusion has been concerned with the role of changes in the stimulus materials, methods of presenting the materials and the kind of instructions given to the subjects.

Kofsky (1966) approached the problem of class inclusion by looking at the way children handle "all" and "some" relations, which Piaget believes to be a necessary condition for class inclusion to develop. The study indicated that the knowledge of "all" and "some"; class addition (A + A'); class subdivision (B>A) was important in the understanding of the class inclusion concept. As the child understands the meaning of the quantifiers "all" and "some", he can describe the extent to which classes overlap. With the development of class addition, he can join subclasses to form a superordinate class, and with the development of class subdivision he can divide superordinate classes into constituent parts. When finally the child develops part-whole inclusion he can keep in mind the logical relationships between the subclass and the whole superordinate class. (Kofsky, 1966, p.212).

The intractable nature of the class inclusion problem has been investigated by Wohlwill (1968). He administered two forms of a class inclusion task, a pure verbal form and a pictorial form to 20 American children, with an average age of 5 years and 11 months. In the pure verbal condition, the subjects were asked: "Suppose I have 6 apples and 2 bananas, would I have more apples or more fruit?". In the pictorial condition, the subjects were presented with pictures of the classes and asked the corresponding class inclusion question. The findings indicated that all the children performed higher on the verbal condition as opposed to the pictorial condition. Wohlwill attributed the highly significant superiority under the verbal condition to what he called the, "weakening of subclasses comparison set engendered by perception of majority and minority subclasses in the standard pictorial condition." (1968, p.453).

Wohlwill suggested that when class inclusion items are presented in a pictorial form, perceptual sets are elicited by the stimuli. This means that the perception of two contrasting subclasses unbalanced as to number creates a strong tendency to make the problem one of subclass comparison.

In a further study involving children's responses to verbally and pictorially presented class inclusion items, Winer and Kronberg (1974) supported Wohlwill's (1968) findings. The authors presented 24 subjects from kindergarten through to grade six with 8 verbal and 8 pictorial items. The children were questioned about the relative size of the superordinate class and the larger of the two subordinate classes. The results showed that the purely verbal form of the question was less difficult than the pictorial form.

Wohlwill's (1968) findings stirred a lot of criticism from other researchers. Jennings (1970) criticized the facilitation effect of verbal presentation on class inclusion competence. He suggested that Wohlwill failed to present complete data on the child's understanding of verbally presented questions and justifications of his responses.

Jennings' study examined the effect of verbal and pictorial presentation on class inclusion competence and performance. He also considered the child's justifications for his answers. His subjects were 78 boys from kindergarten through to third grade and their mean ages ranged from 5 years and 11 months to 9 years and 6 months.

The items used in Jennings (1970) study were taken from Wohlwill (1968) and Inhelder and Piaget (1964). The findings indicated that there was no perceptual disparity and no differences occurred between the verbal and the pictorial presentation for the Inhelder and Piaget items. With Wohlwill's items however, the subjects gave significantly more correct initial and justified answers to pictorial items. Jennings (1970) concluded that his subjects' responses were facilitated by pictorial rather than verbal presentation of items.

This lack of agreement among investigators as to which materials facilitated children's responses to class inclusion items stimulated much interest. Winer (1974) conducted a study to show that Wohlwill's (1968) "verbal facilitation effect" was due to variations in verbal cues as opposed to differences in pictorial cues. Winer presented 72 children, 24 in each of grades two, three and four with 3 sets of conditions. The first set consisted of verbally elaborate questions; the second set had pictorial items while the third set had verbally elaborate pictorial questions. The findings indicated that the means of the verbally elaborate pictorial condition and the means of the purely verbal condition were not significantly different. Winer remarked that these findings demonstrated that verbal cues are of greater significance in class inclusion reasoning than pictorial cues. The distracting effect of perceptual cues as suggested by the verbal facilitation effect are of minimal significance and the linguistic cues may be more significant.

The above findings are inconsistent with Piaget's view that if children are presented with class inclusion questions in the absence of concrete materials, their performance should be lower than if concrete props were provided. Earlier studies by Dodwell (1962) and Smedslund (1964) desmonstrated that when materials used are concrete, children are able to appreciate when there is no one-to-one relation between the classes or items concerned. Furthermore, children are more likely to have experienced a variety of different connections with such concrete material and hence find it easier to generate and assess hypothetical relations between the facts.

Recent attempts have been made to characterize the information-processing strategies the child adopts when he receives a class inclusion problem (Klahr and Wallace, 1972; Meadows, 1977; Wilkinson, 1976). These models have drawn attention to difficulties the child may experience, for example those associated with identifying, counting and comparing class and subclass. In adopting some information-processing strategy however, the child operates on certain assumptions about what the task requires on class inclusion. It has been proposed that in standard presentations of the task, the perceptual characteristics of the array may encourage the young child to adopt the erroneous assumption that the task requires comparison of one part of the array with another part rather than one part of the array with the whole (Wohlwill, 1968; Ahr and Youniss, 1970; Youssef and Guardo, 1972; Kalil, Youssef and Lerner, 1974). This means that in standard presentations, the array typically consists of two subclasses whose distinction is perceptually salient (e.g. the brown and white beads) and this may encourage the young child to assume that the task requires comparison of these distinct constituents. This suggests that if improvements in performance are to be obtained, this assumption needs to be discouraged.

The importance of using alternative presentations of the class inclusion task is illustrated in a series of six experiments conducted by (McGarrigle et al; 1978). These experiments aimed at discouraging the child's assumption that the task involves comparison of salient subclasses, and examined the young child's ability to compare included and nonincluded classes. Children 3 to 5 years old were presented with arrays which contained more than one salient feature. The materials used were model farmyard animals (cows), each of which could vary according to its colour (black or white) and its posture (standing up or lain sleeping on its side).

The question posed in the standard form of the task was: "Are there more black cows or more cows?" In the alternative form of the question, the children were asked "Are there more sleeping cows or more white cows?" The results showed that performance on the alternative presentations was significantly better than on the standard presentations. The alternative presentations were effective to some extent in discouraging the typical assumption that the inclusion task requires comparison of subclasses. It is when this assumption is discouraged, by amending the perceptual or linguistic aspects of the presented information, that the child's performance improves. These findings, that 3 to 5 year olds can succeed on inclusion problems, runs counter to Piaget's claim that young children do not have the ability to complete inclusion problems correctly.

The lack of conclusive evidence on how the young child arrives at class inclusion solutions has produced an upsurge of intervention studies. The studies that follow represent a great number of studies which have attempted to induce the class inclusion concept experimentally.

Training Studies

One of the primary areas which demands methodological consensus is the general body of research literature dealing with the training or experimental induction of Piagetian logical operations skills. As Beilin (1971) has made clear, there is a striking lack of agreement as to what represents a genuine operational measure of the logical behaviour in question and what should be accepted as unequivocal evidence for the efficacy of a particular training program.

During the last decade, a number of interesting viewpoints have been expressed by investigators on the role that training may serve to accelerate concept acquisition. Most supporters of Piaget argue that it is impossible to alter the sequence or bring about too rapid a change. Freeberg and Payne (1967) argument focussed on Bruner's (1960) position that "almost any subject matter if properly organized can be taught at the pre-school level." At somewhat the other extreme is the essentially maturational position of Inhelder and Piaget (1958) who argue for specific levels of cognitive development that must be achieved before certain conceptual strategies can be learned. Ausubel (1965) looks upon Piaget's conceptual stages as "nothing more than approximations that are susceptible to environmental influences" (p.11).

The training methods that Piaget's theory regards as correct are those which incorporate some provision for active self-discovery of the concepts being trained. Active self-discovery learning is emphasized because it is believed that "active self-discovery is what happens in development" (Sinclair, 1973, p.58). It follows from this assumption that the best teaching strategies are those in which the teacher tries to make the child himself "the mainspring of his development, in that it is his own activity on the environment or his own active reactions that make progress" (Sinclair, 1973, p.58).

Inhelder, Sinclair and Bovet (1974) have given the Genevan viewpoint on the learning and development of cognition. In a comprehensive training procedure to induce the logic of class inclusion, they made exclusive use of self-discovery training methods. After a pretest with the standard Piagetian class inclusion problem with beads, 12 subjects aged from 5 years and 9 months to 7 years and 9 months were selected for training. The training procedure was presented immediately after the pretest and was divided between two sessions each lasting for about 20 minutes.

The training procedure consisted of having children add and subtract elements from various concrete classes using fruits, flowers and animals. Specific addition and subtraction operations were hinted at by the experimenter, but she never told the subjects whether any of their answers were correct or incorrect. The subjects were required to provide justifications for their responses. The results showed that the training procedure was effective. The authors argued that many subjects in the different training experiments made real progress, but that such progress was dependent on the subjects' initial developmental level. Although the acquired knowledge was found to generalize to some conservation problems, the authors argued that they had little idea of the extent to which the early acquisition of one concept speeds up the grasp of a more advanced concept later. Whether or not real progress under training has any long term effect in relation to the growth of other concepts, "we simply do not know" (p.247).

Performance on the class inclusion task appears to be subject to a variety of instructional set and task format variations. An early study by Morf (1959) compared instructional treatments consisting of direct demonstration, free exploration and supplying specific perceptual clues.

None of these treatments were found to be notably successful among 4- and 7-year old Genevan children. Training based upon class intersection and multiple classification settings was successful, however, and these results were cited as "evidence for skill mastery based upon a simpler logical structure as a developmental precursor for the more complex class inclusion ability."

Attempts to distinguish between methods which place particular emphasis on subjects' justifications of responses, is a further refinement of the class inclusion training designs (Lasry and Laurendau, 1969). Using a transfer design and a control group, 40 subjects were trained to respond correctly to class inclusion problems and to justify all their answers with operational arguments. Verbal and pictorial material were used in the training sessions. None of the experimental subjects gave correct answers during the first training session. With concrete materials in the second session, however, considerable improvement and transfer was obtained.

Some evidence for generalization to far-transfer tasks was found for children who demonstrated specific transfer following class inclusion training (Inhelder and Sinclair, 1969). The authors demanded valid explanations and correct responses to the class inclusion problems. The results indicated that the direct training approach consist primarily of task-specific performance improvements similar to learning a rule procedure (Beilin, 1965), and the proportion of subjects passing the class inclusion task depend upon the relative stringency of the scoring criteria for the performance that are applied.

Swartz (1971) found that prior training on simpler class inclusion problem formats facilitated subsequent performance on more difficult problems, while instruction that focussed upon the most difficult problems interfered with later performance on tasks of lesser difficulty.

Investigators have contrasted active self-discovery training with the more traditional methods in which teaching is a matter of presenting the correct answers that the learner gives back to the teacher (Kamii, 1973).

One of the most elaborate sets of teaching techniques was developed by Kohnstamm (1967), in which 60, five-year-old Dutch kindergarten children were trained to solve class inclusion problems. The training technique included simple feedback (pointing out correct and incorrect answers to the children and explaining how the answers were correct or incorrect); child manipulation of materials; experimenter demonstrations; and didactic teaching of the rules of class inclusion. He managed to accelerate development in many of the children. This study also demonstrated that it is difficult to know precisely what the "active ingredients" of training may be. Ahr and Youniss (1970) study examined the effects of various instructional techniques on class inclusion performance. It was found that for 6 and 8-year old subjects who initially failed the tasks, correction training following error responses served to improve performance. Since the feedback procedure and the correction of erroneous responses improved performance, the authors were led to conclude that the inability of younger children to make correct judgments may be a performance and not a competence problem.

Tutorial training procedures have also been found useful in assisting young children to re-focus on the relevant and appropriate features of the class inclusion tasks, leading to correct solutions. Hatano and Kuhara (1972) utilized a feedback and explanation procedure to train thirteen, 5- and 6-year old Japanese children to answer class inclusion questions correctly. The training programme consisted of six tasks with pictorial class inclusion problems and verbal inclusion problems. The procedure was repeated many times until the subjects acquired the concept. The findings indicated that 8 of the 13 subjects acquired not merely the "inclusion response" but a true grasp of the inclusive relation. The authors pointed out that prompting questions and auxiliary training played an effective and "remedial role" in the experiment. Thus, they were able to confirm the assertion that an intensive training programme is effective in training five- and six-year old children to grasp the logical relations of two classes.

Using a similar framework, Sheppard (1973) designed a training programme for developing an awareness of class inclusion in 6-year old children who were non-operational on a class inclusion pretest. Thirty-seven subjects were randomly assigned to experimental and control groups. The experimental group received two training sessions of 30 minutes each. The subclasses were formed by two cylinders, A_1 and A_2 with seven red marbles each. Two blue marbles were later introduced to the set A_2 to form the larger superordinate class B. The subjects were trained to elicit the logical sequence, $A_1 = A_2$; $B > A_1$; therefore, $B > A_2$. The training schedule was found to be effective in assisting subjects to improve their performance on class inclusion items, 1-2 weeks later and 3-4 months later. An overall enhancement was noted in the experimental group only, provided by an increase from first to second posttest scores.

Several studies have confirmed that class inclusion training produces significant gains in the performance of inclusion problems. Aldrich (1970) trained 31 kindergarten children with play tiles and picture items, after failing on tests involving questions about the quantification of inclusion, with beads, geometric shapes, pictures and verbal items. The results showed that the trained group performed better than the control group and about 29% of the subjects were able to maintain a high level of operational functioning six weeks after training. There was limited transfer to the beads items. These results were borne out in a study by Robinson (1975). He trained eleven children, aged between 5 and 6 years to respond correctly to questions concerning a superordinate class including its subclasses. Using pictures of 4 carrots and 2 pieces of corn, the corresponding question was, "Are there more carrots or more vegetables?" Analysis of the posttests indicated that the experimental group performed significantly better than the control group. Similar findings have been reported in studies of class inclusion training (Markman 1973; Brainerd, 1974; Wilkinson, 1976; Siegel et al, 1978) where the trained subjects have performed significantly better than the non-trained subjects. These results have led to the conclusion that young children are capable of sophisticated logical reasoning, at least under some circumstances and their failure in class inclusion may be partially a result of the linguistic difficulty of the question.

In summary, the literature relating to the acquisition of the class inclusion concept indicates that the use of various methods and materials lead to varying degrees of success in inducing this operational concept. Training studies also suggest that young children are capable of inferential processes if age and child appropriate tasks are used. Piaget's position that young children cannot be taught operational concepts like class inclusion, has to be reconsidered in light of the increasing evidence that young children can make logical inferences, understand numerical invariance and understand classification systems if we pose the questions in a way to reveal these processes.

Investigators have also varied the testing materials and environments of their studies in order to find out the reasoning skills that different children use to arrive at the responses they give. The following is a brief attempt to point out some of the ways in which investigators arrive at interpretations of children's responses when these children come from a different and/or unfamiliar setting.

Cross-Cultural Studies

During the past decade, cross-cultural psychologists have attempted to distinguish between variables and instruments which might be regarded as valid and reliable for cross-cultural comparisons. These attempts have raised serious doubts concerning whether any one instrument can be said to be measuring the same disposition in the context of a different language and system of conventionalized meanings. While there are no generally accepted or followed rules for allaying these doubts, studies have shown that certain properties of the environment are functionally more important for some cultures than for others, and therefore, familiarity might improve the ability to discriminate important features of a stimulus found in a particular environment.

In cross-cultural research, two assumptions have been widely made about children's correct and incorrect responses in a cognitive assessment situation. Firstly, that the child who fails does not have the logical mechanism needed to coordinate separate information in an inference. Secondly, that the child who succeeds possesses this mechanism. This situation can be erroneous since failures may well be caused by factors other than an inability to make inferences. Incorrect responses could be due to a misunderstanding of the questions, instructions, and other task demands. The child may simply forget the information required and if he could remember it, he could probably organize it in an inference. On a similar plane, successes may also be questionable since it is not always certain that the child who answers the question correctly makes a genuine logical inference. It is possible to do so by parroting a verbal label picked up in the initial training.

A number of cross-cultural studies have demonstrated that under appropriate conditions and with familiar test materials, very different patterns of responses have been obtained. They have also found that familiarity with the materials about which subjects are asked to reason is an important prerequisite if subjects are expected to apply a cognitive skill which they might have. Price-Williams (1975) however, emphasizes that familiarity needs to be extended to the nature of the task required of subjects (not just the type of materials used) and also to the context in which the task is embedded.

A few studies are cited below to illustrate the way familiarity with stimulus materials has been shown to enhance children's performance in cross-cultural settings.

Price-Williams (1962) investigated the ability of the Tiv (Nigerian) children in making conceptually hierarchical classifications. The children were asked to classify and sort models of animals known in the area and also indigenous plants actually picked in the neighbourhood. The materials were exemplars of animals (cows, goats, sheep and hens) and plants (millet, cassava and yams) with which the children were familiar and had had many opportunities in manipulating. Results showed that Nigerian children performed at a higher level of operating relative to

English children in classifying and abstracting the common features of these indigenous materials. The author stresses that the level of performance was enhanced by familiarity with the materials used. Price-Williams also recognized that the language of the Tiv provided for dealing with concrete and abstract categories of objects. Thus, an abstract word distinguished animals which were clawed from those which were hoofed; another word distinguished domestic from wild animals. He found that his subjects could classify according to functional principles given the right materials. He concluded that the use of abstract thinking does occur among the children he tested, but that cultural circumstances determine its areas of application.

In a recent study designed in the same lines as the Price-Williams' study, Fjellman (1971) found among the Kamba children in Kenya that using animals for sorting experiments, instead of geometric shapes, produced better results. She used animals familiar to Akamba children and found that the children were able to abstract attributes common to two or three exemplars. Kellaghan (1968) reports a study in which he used local materials to investigate classificatory behaviour among the Yoruba (Nigerian) children. Like the above studies, his study also showed that when appropriate test materials are used, African children are not qualitatively different from their European counterparts in abstract reasoning.

Cole and Gay et al, (1971) research among the Kpelle of Liberia utilized learning tasks that were highly dependent on subjects' abilities to classify and reclassify familiar stimulus materials. After a series of experiments, it was found that the Kpelle and American children could be shown to be either quite similar or quite dissimilar depending upon the particular experimental arrangements which were used. Of major importance was the finding that when culturally relevant materials (rice, leaves) local and indigenous to the culture were used, the Kpelle performed significantly better than their American counterparts. These mundane objects were found to be more useful than materials that are standard in the western culture, and to enhance the performance level of the subjects.

In a study among the Mano tribe, a subsistence rice farming group in Liberia, Irwin and McLaughlin (1970) found that sorting cards with triangles and squares produced inferior results to sorting rice bowls which differed in size, type of rice, and cleanliness of grain. Among the Mano, swamp rice and land grown rice are never eaten mixed together while cleanliness of the rice is a salient factor. The results showed that compared to American undergraduates who had a higher number of sorts than the Mano group for the geometric shapes, the illiterate Mano farmers had a higher number of sorts for the rice tasks than the Americans.

Following this trend, Okonji (1971) examined the effects of familiarity on classificatory behaviour among Nigerian and Scottish children. He found evidence of superiority of classifying material at older age levels for the Nigerian (Ibusa) group of subjects over the Glasgow (Scottish) group when the materials to be sorted were more familiar to the African group. No differences were obtained when objects which were equally familiar were employed.

Similar findings have been reported by Kamara (1971) and Otaala (1973). The most important factor shown in these studies is that when children from a different culture are tested on materials that are grossly unfamiliar, a severe handicap results. When a set of familiar objects are employed, the performance level of the subjects is enhanced. Implicit in these findings is the fact that an understanding of the world around us helps us to gather and interpret information about it. Consequently, we are far more superior in interpreting those properties of our environment that are functionally more important to us than to other people living outside the culture.

These cultural variations have received various interpretations from different researchers. One of those interpretations centres on the distinction between competence and performance.

Competence and Performance

In cross-cultural investigations, the problem of interpretation arises because of a confusion between competence and performance, and the fact that one can change a child's performance without changing his competence. Much confusion could be avoided in the field if the distinction between competence and performance were kept in mind and if investigators stated clearly which aspect of behaviour they were attempting to demonstrate.

The distinction between the ability to do something and actually doing something is significant to interpretations arrived at. How does a researcher explain the fact that younger children fail a certain concept while older children pass it? Or how does he explain the fact that subjects from certain environment or culture fail a certain concept while subjects from another environment pass it? Brainerd (1978) points out that there are many factors that can spuriously inflate test difficulty and cause subjects to fail even though they have the relevant concept. In the case of young children, they may not yet have acquired the relevant supporting skills that are required to pass the test. In the case of children from a different environment, incorrect responses may be due to an unfamiliar testing situation, the materials and language used may lead to a misunderstanding of the instructions or questions.

Dasen et al, (1979) suggests three ways of assessing the extent to which overt responses truly reflect the underlying structures and hence bringing about the required competence. These methods include Piaget's clinical method, using a variety of techniques instead of a single task, and using training techniques. These techniques have been found useful in making a distinction between difference in competence and differences in performance.

In recent psychological research among cross-cultural groups of subjects, inferences from "poor performance" instances have often been made in which subjects have given wrong responses to questions. In such cases poor performance has been interpreted as being deficient or lacking in the concept under investigation. Kamara and Easley (1973) caution that this kind of performance may not necessarily imply a cognitive deficit but could be due to the questions asked, instructions given or other testing procedures employed which may simply have not elicited the appropriate responses. Similarly, Dasen (1977) points out that:

> When applying a Piagetian task intraculturally but even more so cross-culturally, the results represents a "performance level" that may or may not reflect the "competence" for the operations which the task is supposed to measure. A lot of care is needed to insure that the performance level is equivalent to the competence level. (1977, p.10).

Implicit in the above attempts to distinguish between competence and performance, is the idea that the kind of research which reports deficiencies and not differences provides no answer to the question of a possible relationship between certain important aspects of culture on the one hand and differences in cognitive development on the other. Cole and Bruner (1971) caution against "inferences about lack of competence" while interpreting responses. They argue that those groups ordinarily diagnosed as culturally deprived have the same underlying competence as those in the mainstream of the dominant culture "... the differences in performance being accounted for by the situations and contexts in which the competence is expressed" (p.238).

It appears then that the way in which competence is used in any given situation is culturally determined. This has led Cole and his co-workers to conclude that "We are unlikely to find cultural differences in basic component cognitive processes ... however, cultural differences are found in the way these basic processes combine into "functional cognitive systems" for various purposes." (Cole and Scribner, 1974, p.193). Supported by evidence from their various studies, these authors maintain that competence for operational structures is likely to be universal. Their position is that,

> ... cultural differences in cognition reside more in the situations to which particular cognitive processes are applied than in the existence of a process in one cultural group and its absence in another. (Cole, et al, 1971, p.233).

Justification Question

According to Inhelder and Sinclair (1969) the child's justification of his answers is one of the conditions that should be satisfied in the final evaluation of the acquired learning after training. In Genevan work, there is often the statement that one important way of distinguishing among answers is in terms of whether or not the judgment is made.

A number of researchers, particularly many of the persons who have had to deal with cross-cultural material have found the criterion of justifying one's responses either unnecessary or inappropriate. In conservation studies, for example, researchers ask whether the judgment is based on a grasp of such principles as reversibility and compensation and whether it is possible for the child to meet the second criterion but not have a grasp of compensation. Working with clay, for instance, the child may know that the amount of clay remains the same after a change into a sausage shape but may not know that this is because a change in one property, the length of the piece, is compensated for by a change in another, the thickness of the piece. The child may fail this task but still be able to say that the amounts remain the same in the standard procedure for a conservation task. Such discrepancies in what the child can do have prompted Bruner to wonder whether compensation is a necessary basis for conservation judgments (Bruner, et al, 1966). In Geneva, the same discrepancies prompt the argument that conservation judgments by definition are based on a grasp of compensation.

In a recent study on the conservation of mass, weight, and volume among Kamba children of Kenya, Kiminyo (1973) provides new evidence regarding the justification question. He attempted to answer the question as to whether justifiers were better than non-justifiers in their conservation responses. After a careful analysis of the responses, he found that the mean scores for justifiers were not significantly different from the mean scores of the non-justifiers. Since the performance for justifiers did not differ significantly from the performance of non-justifiers, the justification criterion was dropped in the final analysis and the judgment only criterion was used as a sufficient condition for the discovery of conservation. The author further points out that "... it was felt that inclusion of the justification criterion for conservation had the disadvantage of reducing the total number of subjects by at least one third." (1973, p.87).

In his study among the Aborigines of Australia, Dasen (1974) points out that he found it more useful to use the flexibility of Piaget's clinical method than to make suggestions and countersuggestions which are usually made to test the stability of the answers. This criterion was omitted because "... the Aboriginal child is not used to expressing and maintaining his own opinion. Any countersuggestion is likely to be taken as criticism, and the subject will change his answer." (1974, p.389).

These investigations seem to indicate that explanations were in fact inappropriate criteria for assessing the presence of cognitive structures. It is maintained that some subjects may actually possess the cognitive operations being assessed but fail a test that demands their expression in language. This is drawing on Piaget's assertion that language is dependent on operativity such that a cognitive operation may develop prior to the individual's being able to express that operation in language with the reverse never occurring.

Brainerd (1973) maintains that much of the inconsistency in the conservation literature as to the age at which children conserve and the sequence of acquisition of different concepts can be attributed to which of these two criteria, judgments only or judgments plus explanations, was used. Brainerd's resolution of the issue is that only judgments should be used to infer the presence or absence of conservation. Further, Brainerd points out, that the fact that sequence is found more often using judgments only than using judgments plus explanations, is somehow evidence for the claim that the rate of error for the judgements-only criterion is less than that for the judgements plus explanations criteria.

It seems clear from the above studies that there is a definite problem in maintaining that subjects should justify the judgments they make. Kuhn (1974) provides the generalization that "... the most trustworthy methods for assessing the attainment of a given cognitive structure are those that elicit a variety of responses, both verbal and nonverbal, and make an inference based on this constellation of responses." (1974, p.591).

Summary

Piaget's theory and the research relating to class inclusion indicates that class inclusion problems as they are typically presented contain two main features: an array consisting of a set of objects readily distinguishable into subclasses, and a question which asks for comparison of the whole class with one of these distinct subclasses. The question asked typically involves reference to the distinction that is readily available in the array.

1. Piaget's research shows that the preoperational child fails class inclusion problems because he compares subclasses instead of a subclass with the whole class, due to his lack of reversibility.

2. Piagetian view of learning assumes that certain developmental prerequisites must be layed in before subjects can benefit from learning experiences.

3. Class inclusion studies have not conclusively shown which materials or methods facilitate children's understanding of class inclusion problems. There is lack of agreement as to which materials or methods work best.

4. Training Studies have confirmed that young children's performance on class inclusion tasks may improve if certain aspects of the array, question or method of task presentation are amended. A lack of methodological consensus exists and investigators are not in agreement as to what re-

presents a genuine operational measure of class inclusion after a training program.

5. Cross-cultural research has shown that the erroneous interpretations which have been reported so many times when dealing with children from a different setting, may not necessarily reflect some basic incapacity, and can be bridged through the use of familiar materials.

6. To distinguish between differences in competence and differences in performance, Piaget's clinical method, using a variety of materials, and training techniques have been found useful.

7. In cross-cultural settings, the criterion of justifying one's responses has been found inappropriate. No significant differences have been shown between justifiers and non-justifiers, in their understanding of the concept under study.

It would seem from this review that before general curriculum programs dealing with cognitive logical skills are devised, a careful consideration of these issues should be made, and these skills should be shown to be modifiable through experimental training procedures, while important methodological considerations are also made.

CHAPTER THREE

DEFINITIONS, RATIONALE, AND QUESTIONS GUIDING THIS STUDY

Definitions

The following definitions of terms are presented to indicate their specific connotations within the context of this study.

Class A class is defined as a group of objects or elements which share definite characteristics.

Class inclusion The understanding that a total class (animals) must be bigger than one of its constituent subclasses (cows). When subclasses A (cows) and A' (sheep) additively compose the superordinate class B (animals) then, $B > A$; $B = A + A'$; and $A = B - A'$.

Concrete This refers to the situation in which the objects to be manipulated are specific, tangible and directly observable as opposed to being general, intangible and abstract.

Abstract This refers to something which is not concrete or specific but rather remote from everyday experience.

Close-to-everyday-experience This refers to the situation in which the objects to be manipulated are concrete and familiar to the child, as a result of a direct and practical acquaintance with the objects in question.

Familiarity This refers to the fact that living in a culture means that an individual is exposed to a set of objects that would not be as well known to another person not living in that culture.

Self-discovery This is an approach in which the child must discover the content of what is to be learned himself, by generating propositions that represent either solutions to the problems that are set or successive steps in their solution. The child is the self-correcting monitor of his own behavioural progress and the experimenter avoids telling him whether any of his responses are correct or incorrect.

Tutorial This is an approach in which explicit feedback concerning the effectiveness or degree of accuracy of the child's responses is provided by the experimenter. The experimenter provides a careful specification of the child's correct and incorrect responses.

Verbal This is another way of approaching the class inclusion problem. Here the child is not shown any stimulus materials. He is simply told, for example, "Suppose a farmer has five sheep and three horses, does he have more animals or more sheep?"

Pictorial This refers to the situation in which pictures of the objects to be manipulated are used as opposed to the actual concrete objects.

Rationale

The summary of related theory and research appearing at the end of the previous chapter provides seven basic propositions which underlie this study.

The primary objective of this study was to test the effectiveness of training 5- and 6- year old children to solve class inclusion problems, using different methods and materials. Class inclusion training experiments conducted among preoperational children (Kohnstamm, 1967; Ahr and Youniss, 1970; Hatano and Kuhara, 1972; Sheppard, 1973; Brainerd, 1974; Siegel et al, 1978) provide empirical support for the premise which underlies this postulate: that it is possible to teach preoperational children the relationship between a superordinate class and its subclasses. The training procedures were designed to alert the child, and make him feel at ease with the attributes of the dimensions he was dealing with, so as to lead him to respond to them in a more conceptual or simply a more differentiated fashion.

A second objective of the study was to investigate how far class inclusion was understood, retained and transferred several weeks after training. Attempts were made to detect the factors which were necessary to bring a particular process of reasoning into operation. The purpose was to discover the bases of the subjects' responses and to understand the salient features of the solutions that were given. By introducing variations into the experimental situation and establishing a dialogue between the experimenter and the subject, the children's organizational activities were trained. The aim of this experience was to raise the level of the child's reasoning with regard to the problems set in the training experiments. This study was also concerned with examining ways in which the results of this investigation can be useful in a cross-cultural setting and in exploring the areas that would require modifications in a future (Phase II) replication of this study.

The degree to which different training methods have been useful in accelerating class inclusion concepts largely depends on the researchers' orientation. The Genevan studies (Inhelder and Sinclair, 1969; Inhelder, Sinclair, and Bovet, 1974; Inhelder and Piaget, 1969) have made exclusive use of self-discovery training methods. Tutorial procedures which de-emphasize self-discovery have been extensively used in studies (e.g., Kohnstamm, 1967; Hatano and Kuhara, 1972; Brainerd, 1974; Siegel, et al, 1978). Each of these training methods have been shown to work somehow in teaching children concepts which they do not already know. However, each method seems to go about the problem in a different way. There have been few experiments to date in which self-discovery and tutorial training methods have been compared and hence the evidence bearing on the effectiveness of these methods remains largely inconclusive.

As far as training materials are concerned, Piaget and his coworkers generally lay emphasis on the use of concrete and manipulable materials, although some of Piaget's original studies made use of pictorial materials. Wohlwill (1968) reported some preliminary evidence that seemed to show that verbal class inclusion tests were much easier than Piaget's original ones. Subsequent experiments (Brainerd and Kaszor, 1974; Jennings, 1970; Winer, 1974) have not borne out Wohlwill's findings. In these latter experiments, verbal and concrete class inclusion tests turned out to be equally difficult. These studies have not confirmed the materials which are more effective in teaching class inclusion. With these constraints in mind, the present study attempted to develop a procedure which integrated self-discovery and tutorial methods with concrete, pictorial, and verbal materials. The study thus appears to have potential for overcoming the problems associated with the neglect found in earlier training studies, of combining a variety of methods and materials for effective performance.

Questions Guiding This Study

The review of the research relating to class inclusion did not lead to firm hypotheses due to the inconclusive nature of many of the findings. The postulates used as bases for investigation in this study may therefore be described as guiding questions rather than hypotheses. These postulates served as indicators of those relationships which appeared to be most likely on the basis of previous research. In the previous studies examined, there has been a tendency to investigate the effects of using only one method of training children to acquire class inclusion concepts or one kind of material, but rarely combining a variety of materials and methods in one study. The aim of the present study therefore, was to examine the interaction of different methods and a variety of materials in training class inclusion, in order to avoid overlooking significant relationships which might not have been examined in previous studies. On the basis of these expectations, the following questions were phrased.

1. Immediate Transfer of Class Inclusion: For dependent variable, immediate transfer of class inclusion using beads:
   (a) Are there significant differences among groups trained using different materials: concrete, pictorial, verbal, control?
   (b) Are there significant differences among groups trained using different methods: self-discovery, tutorial, verbal, control?
2. Ten Days Retention of Class Inclusion: For dependent variable, ten days retention of class inclusion using same materials and some of same objects as used for training. For example, the group trained on concrete materials using animals, fruits, and vegetables, to be tested on concrete materials using fruits and vegetables. Questions (a) and (b) above to be asked.
3. Three weeks Retention of Class Inclusion: For dependent variable, three weeks retention of class inclusion using same materials and some of same objects as used for training. For example, the group

trained on pictorial materials with animals, fruits, and vegetables to be tested on pictorial materials using animals. Questions (a) and (b) above to be asked.

4. One Month Transfer of Class Inclusion: For dependent variable, one month transfer of class inclusion using same materials as training materials but objects other than training objects. Questions (a) and (b) above to be asked.

Some Expectations for Alberta Sample

In reviewing the research relating to class inclusion, a number of studies using training procedures indicated that subjects who did not spontaneously display a concrete operational performance level after a pretest, were able to do so after training. This led to the following expectations:

1a. Subjects who receive training through a variety of materials: concrete, pictorial, and verbal will show a higher performance level than the subjects in the control group.

1b. Subjects who receive training through different methods: self-discovery, tutorial, and verbal will show a higher performance level than the subjects in the control group.

There is evidence from previous research that when children are presented with class inclusion questions in the absence of concrete materials, their performance tends to be generally lower than when concrete materials are provided. On the basis of this evidence, the following expectation was formulated:

1c. Subjects who are trained using concrete materials will perform at a higher level than subjects trained using pictorial or verbal materials.

Evidence from observation and previous research suggests that the feedback procedure used in tutorial training programs has a facilitative role in assisting subjects to understand class inclusion concepts. It was on the basis of this evidence that the following expectation was formulated:

1d. Subjects who are trained using tutorial methods will demonstrate a higher performance level than subjects trained using self-discovery or verbal methods.

Previous studies, mainly in cross-cultural settings have provided new evidence regarding the verbal justification question. They have found that subjects who justify their responses do not differ significantly from subjects who do not, in their understanding of the concept under investigation. On the basis of this evidence it was expected that:

2. The performance of subjects who justify their responses will not differ significantly from the performance of subjects who do not justify their responses.

Previous investigations including cross-cultural research have indicated that when questions are formulated in a concrete and familiar way, subjects seem more capable of handling class inclusion problems, than when questions are formulated in an abstract and less familiar way. On the basis of this evidence, an additional expectation which was not formulated in the form of a question, was put forward for testing. It was expected that:

3. The "close-to-everyday-experience" form of task presentation would result in subjects' higher performance compared with a more "abstract" form of task presentation.

It was assumed, for example, that young preoperational children understand the word "eat" and that the choice between questions including that word would be clearer to them than the choice presented in the traditional form of the question, "are there more ... or more ... ?" It is on the basis of that assumption that questions on eating were included in testing the children's class inclusion reasoning skills. (Appendix C).

CHAPTER FOUR

METHOD

Subjects

The subjects who participated in this study were 60 kindergarten and grade one boys (26) and girls (34), aged between five- and six-years. The subjects came from two Edmonton Public School Board schools. These schools were situated in newly developed areas of the city which included expensive family homes and apartments. The schools were therefore, serving a predominantly middle class area. For all the subjects this was their first year in school and none of them were repeaters. The sixty subjects who were trained were selected from among 94 children who were given two pretests and 34 among them were eliminated in accordance with the criteria set in the pretests below. The subjects were then randomly distributed into six treatment groups of 10 subjects each, one of which was the control group. Descriptive data for the subjects are presented in Table 1.

TABLE 1

Descriptive Characteristics of Subjects

N = 60

Variable	Mean	S.D	Range
Age in Months	68.15	5.67	60 - 79
Socioeconomic Status	57.68*	11.39	37.75 - 76.44

* Mean for Canada = 39; S.D = 12

Chronological ages and father's socioeconomic status (at time of enrolment) did not differ significantly for the subjects in the six groups. Socioeconomic status was obtained from the Blishen Scale, a socioeconomic scale for occupations in Canada. (Blishen, 1967).

Pretests

Two pretests were administered to 94 kindergarten and grade one children between the ages of five- and six-years. The first pretest consisted of "all" and "some" items, that is, the fundamental extensive relation which subsists as between a subclass (= "some") and an enveloping class (= "all") and were patterned after Inhelder and Piaget (1964). The subjects were presented with circle and square blocks of different colours and asked to verbalize all the attributes distinguishing the classes. After the subjects had time to look at the blocks, four questions were presented and subjects had to answer all four correctly to advance to the second pretest.

The second pretest consisted of the Piagetian class inclusion test using wooden beads. The subjects were presented with a complete set of 20 wooden beads, 18 of which were brown and two were white. After the subjects had time to look at the beads, and to answer some preliminary questions about the colour of the beads and the material they were made of, two standard class inclusion questions were presented. If a subject was able to answer these two class inclusion questions correctly, he was eliminated and did not qualify for training. The criteria for training therefore, was that subjects had to demonstrate sufficient understanding of "all" and "some" questions, but had to respond incorrectly to the class inclusion questions using beads. (Appendix A).

Training Procedures

The training took place approximately ten days after the pretests. All the subjects who were trained had initially demonstrated that they could discriminate and appropriately label the shapes and colours of blocks in an "all" and "some" pretest. These same subjects, however, had failed the standard class inclusion questions using wooden beads, and had on that basis qualified for training.

The training procedures were standardized insofar as the same basic problems and questions were put to each child, but the flexibility of Pjaget's clinical method was used. Individual subjects were questioned further according to their particular responses. The subjects were allowed to touch, move and manipulate the training objects in any way they liked. The problems and questions posed during the training were organized so as to make the child feel that there was a real problem to solve. However, the questions were adjusted to the specific difficulties of a particular child. The subjects were trained individually.

The two training procedures employed in this study were self-discovery and tutorial methods.

Self-discovery approach is a Piagetian method which stresses the inappropriateness of rewarding or reinforcing children's cognitive activities, both to avoid encouraging children to perseverate at the rewarded level, and to encourage autonomous independent learning activities which are intrinsically rewarding. For the subjects in the self-discovery groups, no supportive comments from the experimenter were given, except encouraging questions to stimulate the subject's curiosity and confidence so that he was able to continue. When a child made an incorrect response, he was not explicitly told that he was wrong but he was guided to correct what he had done. The child had to discover the correct solution to the problem himself, through his own actions. The necessary aids, props and suggestions were provided by the experimenter, which the subjects could use to solve the problems. As such the subjects received the ingredients repeatedly presented but the experimenter never explained how to use them. According to Piaget, children should not be corrected for the mistakes they make because mistakes are a natural by-product of the way children learn.

Tutorial Training is an approach which is primarily associated with a series of experiments conducted by Brainerd and his colleagues from 1972 to 1977 (Brainerd, 1978). The experimenter in this method uses a rewarding or reinforcing procedure. Subjects who were in the tutorial groups were provided with supportive comments, full explanations and immediate feedback as to the correctness or incorrectness of their responses. When a child made a mistake, guiding questions were posed and repeated so as to encourage autonomous, intrinsically rewarding activity. To encourage children to continue with the tasks, motivation was also given by simply praising them. In general the experimenter gave an explanation of the following kind to the subjects in the tutorial groups: "You have to say that there are more B than A because A are also B. A and A' are all B and so there are always more B." The tutorial method of training expresses the active contribution made by the experimenter, while the self-discovery method lays emphasis on the active participation of the child.

Training Materials

Concrete Materials were familiar plastic objects: animals (horses, pigs, and sheep) varied by size, colour, and number; vegetables (tomatoes and cobs of corn); and fruits (bananas, pears, apples, pineapples, lemons, and oranges) varied by number. The subjects could touch, move, and manipulate these objects.

Pictorial Materials were pictures of the same animals, vegetables and fruits as in the concrete situation.

Verbal Materials involved no pictures or concrete objects but verbal questions which made reference to the same objects in the concrete and pictorial conditions. (e.g. "If you had 3 cobs of corn and one tomato, would you have more cobs of corn or more things to eat?").

Control Group received no training but participated in normal class activities for the equivalent period of time. The subjects in this group were pretested and posttested. (Appendix B).

Experimental Design

The six steps of this study are illustrated in Figure 1. The subjects were randomly assigned to each of six groups combining methods and materials:

(i) self-discovery/concrete
(ii) self-discovery/pictorial
(iii) tutorial/concrete
(iv) tutorial/pictorial
(v) verbal
(vi) control

Step 1 of the study comprised the administration of two pretests which were used to select subjects for training.

Step 2 of the study comprised of the training conditions for the six groups using specific materials, methods, and objects for each of the groups. The training consisted of presenting each child individually with the stimulus sets, (e.g. 3 cobs of corn and 1 tomato); (3 apples and 2 pears); (5 sheep and 3 horses), and the relevant class inclusion questions were posed. Each class inclusion question was preceded by questions of the form: "How many cobs of corn are there?" "How many tomatoes?" The class inclusion question, for example, "Are there more cobs of corn or more vegetables?" was asked at the beginning and at the end.

Each individual child was asked these kinds of questions for each stimuli set since different objects were used in the 10 to 30 minutes training. These questions helped the experimenter to ascertain that the subjects knew the names of all the different animals, vegetables, and fruits presented as well as the generic terms for the whole collection.

During the training period, all of the class inclusion items were alike in that they involved a major and a minor subclass and the total class. The method adopted in the training was presenting the test item collections with the two subclasses mixed together rather than separate. It was hoped that this presentation would reduce any likelihood of the subjects encoding the task as a subclass comparison. The necessary superiority of the whole over the part was made clear through the process of counting and separating the various subclass items. In this way, subjects could centre on the comprehension of the logical inclusion of classes.

Based on the components described by Klahr and Wallace (1972), the strategies for teaching class inclusion also included training the subjects to focus and shift attention on wholes and parts, and directing them to compare the elements of the total class and subclasses. Subjects were encouraged to keep in mind the relative sizes of the whole and the parts through counting, prompting and questioning. For example, in the class inclusion problem in which the subject was asked whether there were more brown horses or more animals when presented with 3 brown horses and 1 white horse, the subject was required to count all the animals and then count only the brown horses. The decision of which was more was induced by reminding the subject of the number of items in the class of animals compared with the number of items in the subclass of brown horses. In case of error, immediate feedback was provided by the experimenter for the subjects in the tutorial groups, while further elaboration of the problem was given to the subjects in the self-discovery groups. (Appendix B).

Step 3 of the study comprised the administration of an immediate transfer test of class inclusion using beads. The tasks in this test were presented soon after the training sessions. (Appendix C).

Step 4 consisted of the administration of a retention test, ten days after the training sessions. (Appendix C).

Step 5 consisted of the administration of another retention test, three weeks after the training sessions. (Appendix C).

Step 6 comprised the administration of a transfer test, one month after the training sessions. This test consisted of objects different from the objects used in the training. (Appendix C).

RESEARCH DESIGN

STEPS					
1	2	3	4	5	6
Pretests N = 94	Training Conditions N = 60	Immediate Transfer	Ten Days Retention	Three Weeks Retention	One Month Transfer

"All" and "Some"
Beads Test

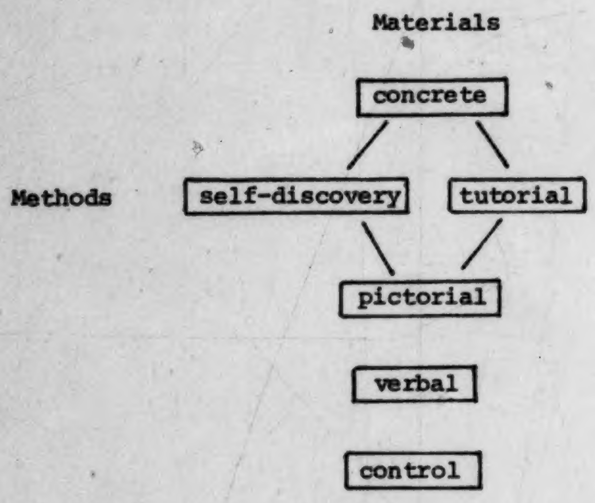
Materials
concrete
Methods
self-discovery
tutorial
pictorial
verbal
control

Figure 1 Flow Chart of Research Design.

Posttests

After the pretests and the training sessions, each subject was asked several class inclusion questions in the four posttests that followed. Each of these posttests employed different questions depending on the stimuli and the group to which the subject belonged.

1. Immediate Transfer Test was administered immediately after the training sessions. The objects used were 20 round wooden beads, 18 of which were brown and two were white. After the subjects had had time to examine the collection of beads, some preliminary questions concerning the properties of the beads (e.g. colour, material) were asked, after which the relevant class inclusion questions were posed and responses with justifications recorded. (Appendix C).

2. Ten Days Retention Test was administered ten days after the training sessions. The items used consisted of the following four sets of fruits and vegetables: (3 bananas and 2 pineapples; 3 apples and 2 pears; 3 oranges and 2 lemons; and 3 cobs of corn and 1 tomato). Subjects were presented with these items and asked to examine them. The corresponding class inclusion questions were asked for each set and responses with justifications recorded. (Appendix C).

3. Three Weeks Retention Test was administered three weeks after the training sessions. The objects used for this test comprised the following four sets of animals: (5 brown sheep and 3 white sheep; 5 big pigs and 3 little pigs; 3 brown horses and 1 white horse and 5 brown sheep and 3 brown horses). Subjects were presented with these items and asked to examine them. The corresponding class inclusion questions were asked for each set and responses with justifications recorded. (Appendix C).

4. One Month Transfer Test was administered one month after the training sessions. The items for this test consisted of animals which could vary according to their colour (white or brown) and posture (sitting on its stomach or sleeping on its side). The sets of items were: (4 white cows and 1 brown cow, all sitting on their stomachs; 4 white cows and 1 brown cow laid sleeping on their sides; and 5 cows and 2 goats). With these objects subjects were asked to compare a class defined in terms of one salient feature (e.g. colour) with an included subclass defined in terms of the other feature (posture). This form of task presentation was intended to discourage the child's assumption that the task involved comparison of salient subclasses, unlike the more standard form of task presentation. The subjects' answers and justifications were subsequently recorded. (Appendix C).

Criteria for Posttests

The final evaluation of the acquired learning after training was carried out by means of the above posttests. According to Inhelder and Sinclair (1969), posttests should satisfy several conditions:

a. Posttests should comprise all the items of the pretest.

b. At least one item should pertain to a structure in a different field but of the same level as the structure that was the object of the learning sessions.

c. Posttests should comprise at least one item pertaining to the same structure but touching on a different problem.

d. Special attention should be paid to the child's justification of his answers.

e. Results should be checked for durability by a control test several weeks later.

In the present study four of the above conditions were satisfactorily met. Condition (b.) was not met due to the constraints in time.

Testing Conditions

Rapport with the children was established by visiting and sitting with the children in their classrooms for a morning or afternoon session (whichever was appropriate) so that they could become well acquainted with the experimenter. No tests were administered during this initial time but the experimenter observed children's activities which clearly indicated that she was interested in what they were doing.

The children were trained and tested individually in a quiet room during normal school hours. Total testing time varied with the number of questions in each posttest, and also depended on each subject's attention and speed at answering questions. Testing time occupied from 7 to 15 minutes with an average of approximately 10 minutes. The sessions were separated by about ten days as indicated in the guiding questions.

Ways to Activate Competence

On the basis of previous research evidence, three methods were employed in the present study in an attempt to bring about children's competence to perform on class inclusion problems.

Firstly, the flexibility of Piaget's clinical method was used to elicit subject's responses. Subjects were questioned further according to the responses they made. This gave the experimenter considerable latitude to formulate hypotheses about the cognitive implications of the child's responses and to devise ways of checking these within the interview situation. Secondly, a variety of materials, objects, and methods were used. These strategies offered a closer approximation to the generalized life experiences found in typical natural settings. Thirdly, the training techniques helped to alert the child to the attributes of the dimensions he was dealing with. These techniques not only provided variety, but also maximized the possibility of provoking the experiences which were productive for particular children during the training period.

CHAPTER FIVE

ANALYSES I : PRELIMINARY ANALYSES

Methods of Scoring

Initially, an exploratory scoring criterion for each item was devised using a 4-category scoring procedure as follows:

0 - incorrect response

1 - correct without justification

2 - correct with inappropriate or incomplete justification

3 - correct with correct justification

When the means of the scores from the test items and the total means per test were calculated using this criterion, there was a clear split in the level of the item difficulties. This split was evident in the "abstract" and "close-to-everyday-experience" items. (Appendix D).

In an effort to examine further the reasoning processes that subjects used to arrive at the responses they gave, another criterion of scoring was established. An attempt was made to approximate the level of class inclusion comprehension at the time of testing. The responses and the justifications given were scored using the following 3-category procedure:

1 - No understanding of class inclusion.

2 - Partial understanding of class inclusion.

3 - Full understanding of class inclusion.

These criteria for scoring the test items were devised principally by the investigator, the latter modelled from the criteria established by Inhelder and Piaget (1964). An attempt was made to construct criteria that would provide both a qualitative and a quantitative assessment of the subjects' performance. The subjects' justification of their answers were integrated into the scoring system. This was deemed desirable because it would indicate the strategies that subjects used to reason out their responses. (Appendix E).

Reliability of Scoring

The investigator and two graduate students independently scored the protocols of a random sample of 4 subjects from each of 6 groups. Using the 4-category procedure of scoring, 2 scorers scored 4 tests with a total number of 24 subjects and the resulting correlations were: .97; .98; .86; .97. Using the 3-category procedure of scoring, 2 scorers scored 4 tests with a total number of 24 subjects and the resulting correlations were: .90; .91; .89; .93. These high inter-scorer correlations provide confidence that the scores obtained with both these procedures were reasonably independent of who did the scoring. The scores of the 3-category scoring procedure were used in the final analyses of the data.

Indications of Test Reliability

The tests for abstract and close-to-everyday-experience items cannot be said to have been strictly parallel or equivalent, but when the pairs of observations were correlated, the following correlations were observed:

1. Immediate Transfer on Abstract items, and
   Immediate Transfer on Close-to-everyday-experience items: .70
2. Ten Days Retention on Abstract items, and
   Ten Days Retention on Close-to-everyday-experience items: .70

3. Three Weeks Retention on Abstract items, and
   Three Weeks Retention on Close-to-everyday-experience items: .72

4. One Month Transfer on Abstract items, and
   One Month Transfer on Close-to-everyday-experience items: .72

These correlations suggest that, were strictly parallel test forms available, test reliability coefficients would be well above .70 to .72.

Sex Differences

No statistically significant differences were found between the scores obtained by boys when compared with the scores obtained by girls. The scores for both sexes were therefore, combined for the analyses in this study. The no-sex difference suggests that the development of cognitive abilities in class inclusion among preoperational children may be heavily influenced by other factors, and that whatever differences there are in the environments of boys and girls at this age do not affect this concept of cognitive development. Generally, most studies comparing preoperational boys and girls have found no sex differences on Piagetian concepts.

Observations during Testing Period

The techniques used during the training period were aimed at making the children accept that "all" the elements of an item were always more than any subgroup of elements in that item. It was observed that counting the classes A and B and comparing the outcome was one of the very important strategies that children used to arrive at their responses. The detour via counting seemed to help subjects find the solution to the inclusion problem. When children were faced with a class inclusion problem, such as, "Are there more fruits or more bananas?", they started by searching for estimates of the quantity of fruits and the quantity of bananas. If they already had such estimates stored in memory, the problem was solved. Otherwise the children had to generate new quantity estimates. It is here in the generation of quantity estimates that the trained and the untrained children differed crucially.

For some children, the learning process itself was characterized by an abrupt switch from incorrect to correct responses. For many of the children, the process was more gradual. It should also be stressed that the training was easy with some subjects but difficult with others. For children who gave correct answers in most of the posttests we might say there must have been some real change in the cognitive processes involved. The step by step procedures used in the training sessions seemed to have activated these processes.

Of special interest to the experimenter, was the observation that those subjects who had participated in the training program seemed to engage themselves actively in the class inclusion tasks during the final testing periods. After a great deal of effort had been expended by the subject in working to solve the task and seemingly, he had grouped the materials in every conceivable way, the child would often strain to accomplish more grouping patterns. It seemed as if he thought he could think of more ways in which one class could be included in another to form a superordinate class.

This was apparently not the case with the child from the control group. More often, this child would arrange his groupings and be unperturbed that he was unable to solve the task in other ways. Unlike the child from the training group, he seemed not to strain for solutions, since theoretically, he had not been exposed to opportunities from which to draw. In most cases, the child from the control group stated that he could not think of anything else and therefore, could not proceed further.

Question Wording

The class inclusion question was asked in two different formulations. Some of the questions were in the "abstract" or more standardized way of asking class inclusion questions, for example, "Are there more fruits or more apples?", while others were worded in a more, "close-to-everyday-experience" form, for example, "If you eat all the bananas and I eat all the fruits, who eats more?". The problem in both cases was, however, the same. That is, given a class B (fruits) made up of two subclasses A (3 bananas) and A' (2 pineapples), the child was asked to compare the number of objects in subclass A with the number in whole class B.

When the class inclusion problem was given in its standard form, many of the children appeared to take longer in finding the correct solution, than when the question was given in a more familiar way. For instance, in response to the question, "Are there more wooden beads or more brown beads?", the child would agree that some beads were brown and some were white; that there were more brown beads than white beads; and that all of the beads were made of wood. But when asked the above question, he would respond again that there were "more brown beads because only two are white."

Some children appeared to think that there was a catch in the question. They would look up at the experimenter to make sure this is what she had asked. When the children seemed doubtful, the experimenter repeated the question, slowly and clearly, and reminded the subject that the beads should all be made of wood, which reassured the child and made it possible for the test to be continued.

For the responses to the immediate transfer of class inclusion:

Typical correct answers were:

> More wooden beads because they are all made of wood.
>
> More wooden beads because you count all of them, and they are all made of wood.
>
> More wooden beads because even the white ones are wood too.
>
> Wooden necklace would be longer because you use all the beads and there are two extra white ones.

Incorrect answers included:

> More brown beads because there are 18 of them and only 2 white.
>
> More brown beads because there's a whole bunch of them.
>
> More brown beads because they seem alot more.
>
> Brown necklace would be longer because there are alot more brown beads than white beads.

Many of the children appeared to have flashes of insight when the class inclusion question was phrased in the more "close-to-everyday-experience" form. For instance, the subjects were presented with a collection of 3 oranges and 2 lemons and asked, "What would you say if you wanted to eat the most: "I'm going to eat all my oranges or I'm going to eat all my fruits?". When the action was thus explicitly placed in the future, the children no longer seemed to regard the result of a mental action (putting oranges together, separating them from lemons, eating them) as being equivalent to that of a real action. The children appeared more comfortable with questions in this form.

For responses to the one month transfer of class inclusion:

Typical correct answers were:

> More cows sitting on their stomachs, because all of the 5 cows (white and brown) are sitting on their stomachs.

> More sleeping cows because all of them are sleeping.
>
> More grass for the animals because there are 7 animals but only 5 are cows.
>
> There are more animals in the world because there's a whole bunch of other animals (e.g. rabbits and bears) which are not cows.

Incorrect answers included:

> More white cows sitting on their stomachs because I can see only one brown cow.
>
> More grass for the cows because they eat alot more.
>
> More grass for the cows because there are 5 cows and only 2 goats.
>
> There are more cows in the world because every farmer has a cow and you see them everywhere.

Formulation of Tests

Using the 4-category scoring system, mean scores for each question were calculated. These mean scores were then added up over the six groups (SD/CON, SD/PIC, TU/CON, TU/PIC, Verbal and Control) to give a total of means for that question. When these total mean scores were examined, there was a clear split between items with means < 10, "abstract" and items with means > 10, "close-to-everyday-experience." (Appendix D).

To set up the eight posttests used in the analyses, the four test times from Immediate Transfer to One Month Transfer were each split into "abstract" and "close-to-everyday-experience".

Reasons for Failure

The children used several methods to solve the class inclusion problems, some of which resulted in excellent progress, while others seemed to lead to an impasse. Children who gave incorrect answers and justifications seemed unable to simultaneously realize that, for example, the same apples which counted as "apples" also had to count as "fruits". Several children from the no-training group in particular were unable to overcome this difficulty.

In general, when the problem of inclusion could not be solved, the most frequent error was to compare A and A', instead of A and B. For example:

> KEV (74 months):
>
> Presented with 5 cows and 2 goats, the subject was asked: "Are there more cows or more animals?" "More cows because there are 5 of them and only 2 goats." "Would a farmer need more grass for the cows or for the animals?"
> "More for the cows because there are more cows than goats and cows eat more."

This shows that the subject reduced B to A' and could not therefore, proceed to use the same elements in two different ways. Another subject, for example, said that, "If the cows A, eat the grass, then the animals B, will have nothing to eat." Thus B had been reduced to A' (goats) by the conscious subtraction of A (cows). To make a genuine quantitative comparison of the part A, and the whole B, the subjects needed to be able to separate B into A and A' (as demonstrated in the training) and still retain its identity, which means the whole B continued to exist even while its components A and A' were separated in thought.

It must be emphasized that immediate feedback as to the correctness or incorrectness of a subject's response appeared to be a critical determinant of learning this complex cognitive skill. By providing adequate feedback, subjects were encouraged to organize and pattern their existing notions about class inclusion reasoning. Although subjects were in general comfortable with all the materials used, they seemed to be more actively involved with concrete materials which they could manipulate. This enhanced their attention, memory, and ultimate understanding of the class inclusion concepts.

CHAPTER SIX

ANALYSES II : MAIN ANALYSES

Summary of One-Way Analyses of Variance

One-Way Analysis of Variance was used to test the significance of the differences between the means obtained by subjects in the six treatment groups. The F statistic was used to compare the relative effectiveness of materials, methods, and materials crossed with methods, on the abstract and close-to-everyday-experience posttests.

Summaries of the One-Way Analyses of Variance from Immediate Transfer of Class Inclusion to One Month Transfer of Class Inclusion are presented in Table 2 (materials), Table 3 (methods), and Table 4 (materials crossed with methods). Overall significant F ratios were obtained ($p < .01$) for materials, methods, and materials crossed with methods for each of the eight posttests from Immediate Transfer to One Month Transfer of Class Inclusion. Chi-square tests of independence on the same data gave similar results, but with higher probability ($p < .05$).

Newman-Keuls Multiple Comparison of Means

Since significant overall F ratios were obtained in the One-Way Analyses of Variance, the studentized range statistic (Newman-Keuls Method) was used to make comparisons between pairs of means. The studentized range is defined as ".... the difference between the largest and the smallest treatment means divided by an estimate of the standard error assoc-

TABLE 2

SUMMARY OF ONE-WAY ANALYSES OF VARIANCE (MATERIALS) FROM IMMEDIATE TRANSFER TO ONE MONTH TRANSFER

Variable	df	MS	F	p
Immediate Transfer on Abstract Items	3 56	2.91 0.54	5.43**	0.002
Immediate Transfer on Close-to-everyday-experience Items	3 56	3.60 0.59	6.07**	0.001
Ten Days Retention on Abstract Items	3 56	3.28 0.56	5.89**	0.001
Ten Days Retention on Close-to-everyday-experience Items	3 56	3.81 0.62	6.19**	0.001
Three Weeks Retention on Abstract Items	3 56	2.91 0.54	5.43**	0.002
Three Weeks Retention on Close-to-everyday-experience Items	3 56	4.25 0.55	7.76**	0.0002
One Month Transfer on Abstract Items	3 56	4.28 0.57	7.45**	0.0002
One Month Transfer on Close-to-everyday-experience Items	3 56	4.28 0.57	7.54**	0.0003

** $p < .01$

TABLE 3

SUMMARY OF ONE-WAY ANALYSES OF VARIANCE (METHODS) FROM IMMEDIATE TRANSFER TO ONE MONTH TRANSFER

Variable	df	MS	F	P
Immediate Transfer on Abstract Items	3 56	2.68 0.55	4.88**	0.004
Immediate Transfer on Close-to-everyday-experience Items	3 56	3.43 0.60	5.71**	0.002
Ten Days Retention on Abstract Items	3 56	2.94 0.57	5.13**	0.003
Ten Days Retention on Close-to-everyday-experience Items	3 56	3.64 0.63	5.83**	0.002
Three Weeks Retention on Abstract Items	3 56	2.68 0.55	4.88**	0.004
Three Weeks Retention on Close-to-everyday-experience Items	3 56	4.12 0.55	7.42**	0.0003
One Month Transfer on Abstract Items	3 56	4.08 0.58	6.97**	0.0005
One Month Transfer on Close-to-everyday-experience Items	3 56	3.94 0.58	6.74**	0.0006

** $p < .01$

TABLE 4

SUMMARY OF ONE-WAY ANALYSES OF VARIANCE (MATERIALS CROSSED WITH METHODS) FROM IMMEDIATE TRANSFER TO ONE MONTH TRANSFER.

Variable	df	MS	F	p
Immediate Transfer on Abstract Items	5 54	1.95 0.54	3.62**	0.007
Immediate Transfer on Close-to-everyday-experience Items	5 54	2.24 0.61	3.69**	0.006
Ten Days Retention on Abstract Items	5 54	2.02 0.57	3.52**	0.008
Ten Days Retention on Close-to-everyday-experience Items	5 54	2.39 0.63	3.79**	0.005
Three Weeks Retention on Abstract Items	5 54	1.95 0.54	3.62**	0.007
Three Weeks Retention on Close-to-everyday-experience Items	5 54	2.60 0.56	4.62**	0.001
One Month Transfer on Abstract Items	5 54	2.70 0.58	4.62**	0.001
One Month Transfer on Close-to-everyday-experience Items	5 54	2.66 0.58	4.58**	0.001

** $p < .01$

iated with a single treatment mean". (Ferguson, 1976, p.297). The means were rank ordered from low to high and the studentized ranges were obtained for all pairs of means. Criterion values of Q for comparing two means were set at the .05 level. The following analyses used these Q values to examine the questions guiding this study.

I Immediate Transfer of Class Inclusion

The first guiding question in this study that subjects exposed to a training program through concrete, pictorial and verbal materials will transfer their acquired learning immediately to a class inclusion test using beads, and that subjects who received no training will be unable to do so, received support from a comparison of pairs of means between the treatment groups and the control group. Separate tests on the Immediate Transfer Test data were carried out for concrete, pictorial, verbal, and no-training materials, using the abstract and close-to-everyday-experience items.

1. Materials: Table 5 presents the values of Q for the ordered means obtained on the Immediate Transfer Test using various materials. Significant differences were obtained between the means of the trained subjects using concrete, pictorial, and verbal materials and the means of the subjects in the no-training condition. No significant differences were detected between the means of the subjects trained using concrete, pictorial, and verbal materials themselves.

Expectation 1a. that subjects who receive training using concrete, pictorial and verbal materials will show a higher level of performance than the subjects in the control group was supported. The trained subjects were able to transfer their acquired learning immediately to a class inclusion test using beads.

2. Methods: The second part of the first guiding question that subjects exposed to a training program through self-discovery, tutorial, and verbal methods will transfer their learning immediately to a class inclusion test using beads, and that subjects exposed to no-training methods will be unable to do so, received support from a comparison of pairs of means between the treatment groups and the control group.

TABLE 5

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS) FOR IMMEDIATE TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Immediate Transfer on Abstract Items					Immediate Transfer on Close-to-everyday-experience Items				
	NT	P	V	C		NT	P	C	V
MEANS	1.0	1.7	2.0	2.1	MEANS	1.1	2.0	2.3	2.3
NT		3.49*	4.49*	5.49*	NT		4.27*	5.69*	5.69*
P			1.50	2.00	P			1.42	1.42
V				0.50	C				0.00
C					V				

* $p < .05$ NT: No-Training; C: Concrete; P: Pictorial; V: Verbal

Table 6 presents the values of Q for the ordered means obtained on the Immediate Transfer Test using various methods. Significant differences were obtained between the means of the trained subjects using self-discovery, tutorial, and verbal methods and the means of the subjects exposed to no-training methods. There were no significant differences between the means of subjects trained using the various methods themselves.

Expectation 1b, that subjects who receive training through self-discovery, tutorial, and verbal methods will show a higher level of performance than subjects in the control group was supported. The trained subjects transferred their acquired learning immediately to a class inclusion test using beads.

TABLE 6

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (METHODS) FOR IMMEDIATE TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Immediate Transfer on Abstract Items					Immediate Transfer on Close-to-everyday-experience Items				
	NT	SD	V	TU		NT	SD	TU	V
MEANS	1.0	1.8	2.0	2.1	MEANS	1.1	2.1	2.3	2.3
NT		3.70*	4.93*	5.18*	NT		4.47*	5.41*	5.65*
SD			1.23	1.48	SD			0.94	1.18
V				0.25	TU				0.24
TU					V				

* $p < .05$ NT: No-Training; SD: Self-Discovery; TU: Tutorial; V: Verbal.

3. Materials Crossed with Methods: When materials and methods were combined in the same test to find significant differences between subjects trained using: self-discovery methods and concrete materials; self-discovery methods and pictorial materials; tutorial methods and concrete materials; tutorial methods and pictorial materials; verbal methods and materials; and subjects in the control group, significant differences were obtained between each of the treatment groups and the control group. No

significant differences occurred when treatment group means were compared among themselves.

Table 7 presents the values of Q for the ordered means obtained on the Immediate Transfer Test using a combination of materials and methods, on the abstract and close-to-everyday-experience items.

TABLE 7

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS AND METHODS) FOR IMMEDIATE TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

	Immediate Transfer on Abstract Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
Means	1.0	1.6	1.8	1.9	2.0	2.3
NT		2.59	3.45*	3.88*	4.32*	5.61*
SD/PIC			0.86	1.29	1.73	3.02
TU/PIC				0.43	0.86	2.16
SD/CON					0.43	1.73
VBL						1.29
TU/CON						
	Immediate Transfer on Close-to-everyday-experience Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
Means	1.1	1.9	2.1	2.2	2.3	2.4
NT		3.25*	4.06*	4.46*	4.86*	5.27*
SD/PIC			0.81	1.22	1.62	2.03
TU/PIC				0.41	0.81	1.22
SD/CON					0.41	0.81
VBL						0.41
TU/CON						

* $p < .05$

NT: No-Training; SD/PIC: Self-Discovery and Pictorial; TU/PIC: Tutorial and Pictorial; SD/CON: Self-Discovery and Concrete; VBL: Verbal; TU/CON: Tutorial and Concrete

II Ten Days Retention of Class Inclusion

The next question to be answered in the present study that subjects exposed to a training program through concrete, pictorial, and verbal materials will retain their learning over a Ten-Days period when tested on the same materials, and that subjects in the control group will not change significantly, was supported in a comparison of pairs of means between the treatment groups and the control group. Separate tests on the Ten Days Retention Test data were carried out for concrete, pictorial, verbal and no-training materials, and on the abstract and close-to-everyday-experience items.

1. Materials: Table 8 presents the values of Q for the ordered means obtained on the Ten Days Retention Test using various materials. Significant differences were obtained between the means of the trained subjects using concrete, pictorial, and verbal materials and the means of the subjects in the control group. No significant differences were detected when means of the treatment groups were compared among themselves.

It is clear from these data that the variety of materials employed facilitate subjects' retention of class inclusion learning over a Ten-Days period.

2. Methods: To test the question that subjects exposed to a training program through self-discovery, tutorial, and verbal methods will retain their learning over a Ten-Days period, while the control group will not change significantly, a comparison of pairs of means between the treatment groups and the control group was made. This question was supported by significant differences obtained between the means of the trained subjects using these methods and the means of the subjects in the control group.

TABLE 8

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS) FOR TEN DAYS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Ten Days Retention on Abstract Items					Ten Days Retention on Close-to-everyday-experience Items				
	NT	P	C	V		NT	P	V	C
MEANS	1.0	1.8	2.1	2.2	MEANS	1.1	2.1	2.3	2.4
NT		3.67*	5.39*	5.88*	NT		4.42*	5.58*	5.82*
P			1.71	2.20	P			1.16	1.40
C				0.49	V				0.23
V					C				

* $p < .05$ NT: No-Training; P: Pictorial; C: Concrete; V: Verbal

Table 9 presents the values of Q for the ordered means obtained on the Ten Days Retention Test using various methods on the abstract and close-to-everyday-experience items. The various methods facilitated subjects' retention of class inclusion while the control group did not change significantly.

3. Materials Crossed with Methods: A test of the Ten Days Retention of Class Inclusion question is also provided by a comparison of means obtained between subjects trained using a combination of materials and methods, and means of the control group. Significant differences occurred between each of the treatment conditions and the no-training condition. This indicates that a combination of materials and methods facilitated the trained subjects retention of class inclusion learning within a period of Ten days, while there was little change in the control group, as shown in Table 10.

TABLE 9

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (METHODS) FOR TEN DAYS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Ten Days Retention on Abstract Items					Ten Days Retention on Close-to-everyday-experience Items				
	NT	SD	TU	V		NT	SD	TU	V
MEANS	1.0	1.9	2.0	2.2	MEANS	1.1	2.1	2.3	2.3
NT		4.10*	4.82*	5.78*	NT		4.62*	5.54*	5.54*
SD			0.72	1.69	SD			0.92	0.92
TU				0.96	TU				0.00
V					V				

* $p < .05$ NT: No-Training; SD: Self-Discovery; TU: Tutorial; V: Verbal

Expectations 1a. and 1b. that subjects who receive training through a variety of materials and methods respectively, will show a higher level of performance than the subjects in the control group, were supported in the Ten Days Retention of Class Inclusion question.

III Three Weeks Retention of Class Inclusion

The third guiding question in this study that subjects exposed to a training program through concrete, pictorial, and verbal materials will retain their acquired learning over a Three-Weeks period when tested on the same materials, and that subjects in the control group will not change significantly, was supported in a comparison of pairs of means between the treatment groups and the control group. Separate tests on the Three Weeks Retention Test data were carried out for concrete, pictorial, verbal and

TABLE 10

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS AND METHODS) FOR TEN DAYS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

	Ten Days Retention on Abstract Items					
	NT	SD/PIC	TU/PIC	SD/CON	TU/CON	VBL
MEANS	1.0	1.7	1.8	2.0	2.2	2.2
NT		2.93*	3.34*	4.18*	5.02*	5.02*
SD/PIC			0.42	1.25	2.09	2.09
TU/PIC				0.84	1.67	1.67
SD/CON					0.84	0.84
TU/CON						0.00
VBL						

	Ten Days Retention on Close-to-everyday-experience Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.1	2.0	2.1	2.2	2.3	2.5
NT		3.59*	3.99*	4.38*	4.78*	5.58*
SD/PIC			0.40	0.80	1.20	1.99
TU/PIC				0.40	0.80	1.59
SD/CON					0.40	1.20
VBL						0.80
TU/CON						

* $p < .05$

NT: No-Training
SD/PIC: Self-Discovery and Pictorial
TU/PIC: Tutorial and Pictorial
SD/CON: Self-Discovery and Concrete
TU/CON: Tutorial and Concrete
VBL: Verbal

no-training materials, and on the abstract and close-to-everyday-experience items.

1. Materials: Table 11 presents the values of Q for the ordered means obtained on the Three Weeks Retention Test using various materials. Significant differences were obtained between the means of the trained subjects using concrete, pictorial, and verbal materials and the means of the subjects in the control group. No significant differences were detected when means of the treatment groups were compared among themselves.

TABLE 11

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS) FOR THREE WEEKS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Three Weeks Retention on Abstract Items					Three Weeks Retention on Close-to-everyday-experience Items				
	NT	P	V	C		NT	P	C	V
MEANS	1.0	1.7	2.0	2.1	MEANS	1.1	2.2	2.4	2.4
NT		3.49*	4.99*	5.49*	NT		5.18*	6.42*	6.42*
P			1.50	2.00	P			1.23	1.23
V				0.50	C				0.00
C					V				

* $p < .05$ NT: No-Training; P: Pictorial; V: Verbal; C: Concrete

The above data shows that within three weeks, the trained subjects were able to retain their learning of class inclusion while the no-training subjects did not change significantly.

2. Methods: A test of the question that subjects exposed to a training program through self-discovery, tutorial, and verbal methods will

retain their learning over a Three-Weeks period, while the control group will not change significantly, is provided by a comparison of pairs of means between the treatment groups and the control group. Significant differences obtained between the means of the trained subjects using these methods and the means of the subjects in the control group provide support for this question.

Table 12 presents the values of Q for the ordered means obtained on the Three Weeks Retention Test using various methods, on the abstract and close-to-everyday-experience items. The data indicates that these methods helped subjects retain their acquired learning while the control group did not change significantly.

3. Materials Crossed with Methods: A test of the Three Weeks Retention of Class Inclusion question is also provided by a comparison of means obtained between subjects trained using a combination of materials and methods, and means of the control group. Significant differences occurred between each of the treatment conditions and the no-training condition. No significant differences were obtained when comparisons were made between the treatment group means themselves. Table 13 presents the values of Q for the ordered means obtained on the Three Weeks Retention Test using a combination of materials and methods, on the abstract and close-to-everyday-experience items. These data indicate that when materials and methods were combined, subjects were able to retain their class inclusion learning over a Three-Weeks period.

Expectations 1a. and 1b. that subjects who receive training through a variety of materials and methods respectively, will show a higher level of performance than subjects in the control group, were supported in the Three Weeks Retention of Class Inclusion question.

TABLE 12

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (METHODS) FOR THREE WEEKS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Three Weeks Retention on Abstract Items					Three Weeks Retention on Close-to-everyday-experience Items				
	NT	SD	V	TU		NT	SD	TU	V
MEANS	1.0	1.8	2.0	2.1	MEANS	1.1	2.2	2.4	2.4
NT		3.70*	4.93*	5.18*	NT		5.39*	6.13*	6.37*
SD			1.23	1.48	SD			0.74	0.94
V				0.25	TU				0.25
TU					V				

* $p < .05$ NT: No-Training; SD: Self-Discovery; TU: Tutorial; V: Verbal

IV One Month Transfer of Class Inclusion

The fourth guiding question in this study that subjects exposed to a training program through concrete, pictorial, and verbal materials will transfer their acquired learning to a class inclusion test using objects other than the training objects, and that subjects in the control group will not change significantly, received support from a comparison of pairs of means between the treatment groups and the control group. Separate tests on the One Month Transfer Test data were carried out for concrete, pictorial, verbal, and no-training materials, using the abstract and close-to-everyday-experience items.

1. Materials: Table 14 presents the values of Q for the ordered means obtained on the One Month Transfer Test using various materials.

TABLE 13

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS AND METHODS) FOR THREE WEEKS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

	Three Weeks Retention on Abstract Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.0	1.6	1.8	1.9	2.0	2.3
NT		2.59	3.45*	3.88*	4.32*	5.61*
SD/PIC			0.86	1.29	1.73	3.02
TU/PIC				0.43	0.86	2.16
SD/CON					0.43	1.73
VBL						1.29
TU/CON						

	Three Weeks Retention on Close-to-everyday-experience Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.1	2.1	2.2	2.3	2.4	2.5
NT		4.21*	4.64*	5.06*	5.48*	5.90*
SD/PIC			0.42	0.84	1.26	1.69
TU/PIC				0.42	0.84	1.26
SD/CON					0.42	0.84
VBL						0.42
TU/CON						

* $p < .05$

NT	No-Training
SD/PIC:	Self-Discovery and Pictorial
TU/PIC:	Tutorial and Pictorial
SD/CON:	Self-Discovery and Concrete
VBL:	Verbal
TU/CON:	Tutorial and Concrete

TABLE 14

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS) FOR ONE MONTH TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

One Month Transfer on Abstract Items					One Month Transfer on Close-to-everyday-experience Items				
	NT	P	V	C		NT	P	V	C
MEANS	1.0	2.0	2.2	2.4	MEANS	1.1	2.1	2.3	2.5
NT		4.82*	5.78*	6.51*	NT		4.85*	5.82*	6.55*
P			0.96	1.69	P			0.97	1.70
V				0.72	V				0.73
C					C				

* $p < .05$ NT: No-Training; P: Pictorial; V: Verbal; C: Concrete

Significant differences were obtained between the means of the trained subjects using concrete, pictorial, and verbal materials and the means of the control group. No significant differences were detected between the means of the treatment groups themselves.

These data clearly indicate that within one month, the trained subjects were able to transfer their class inclusion learning to a test using the same materials but objects other than the objects used in the training.

2. Methods: A test of the question that subjects exposed to a training program through self-discovery, tutorial, and verbal methods will transfer their learning within one month to a class inclusion test using objects other than the objects used in the training, and that subjects ex-

posed to no-training methods will be unable to do so, is provided by a comparison of means obtained between the treatment groups and the control group. Significant differences obtained between the means of the trained subjects using these methods and the means of the control group provide support for this question.

Table 15 presents the values of Q for the ordered means obtained on the One Month Transfer Test using various methods, on the abstract and close-to-everyday-experience items. These data clearly indicate that the methods used facilitated subjects' transfer of acquired learning to a test using objects other than the objects used in training, while the control group showed little change.

TABLE 15

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (METHODS)
FOR ONE MONTH TRANSFER ON ABSTRACT AND CLOSE-TO-
EVERYDAY-EXPERIENCE ITEMS

One Month Transfer on Abstract Items					One Month Transfer on Close-to-everyday-experience Items				
	NT	SD	V	TU		NT	SD	V	TU
Means	1.0	2.1	2.2	2.3	MEANS	1.1	2.2	2.3	2.3
NT		5.01*	5.73*	6.21*	NT		5.25*	5.73*	5.97*
SD			0.72	1.19	SD			0.48	0.72
V				0.48	V				0.24
TU					TU				

* $p < .05$ NT: No-Training; SD: Self-Discovery; V: Verbal; TU: Tutorial

3. Materials Crossed with Methods: A test of the One Month Transfer of Class Inclusion question is also provided by a comparison of means obtained between subjects trained using a combination of materials

and methods, and means of the control group. Significant differences were obtained between each of the treatment conditions and the no-training condition. No significant differences occurred when comparisons were made between the treatment group means themselves.

Table 16 presents the values of Q for the ordered means obtained on the One Month Transfer Test using a combination of materials and methods, on the abstract and close-to-everyday-experience items. These data indicate that within a period of one month, trained subjects were able to transfer their class inclusion learning using a combination of materials and methods. Expectations 1a. and 1b. that subjects who receive training through a variety of materials and methods respectively, will show a higher level of performance than subjects in the control group, were supported in the One Month Transfer of Class Inclusion question.

Two-Way Analyses of Variance

Two-Way Analysis of Variance was used to test the significance of the differences between the means on each of the eight posttests. Means obtained by subjects trained on self-discovery and tutorial methods, and means obtained using concrete and pictorial materials were used for these analyses. This test also sought to find out whether any significant interaction effects existed among methods and materials.

In illustration, Table 17 presents results of the two-way analysis of variance for the One Month Transfer Test on Abstract Items.

TABLE 16

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS AND METHODS) FOR ONE MONTH TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

	One Month Transfer on Abstract Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.0	1.9	2.1	2.2	2.2	2.5
NT		3.73*	4.55*	4.97*	4.97*	6.21*
SD/PIC			0.83	1.24	1.24	2.48
TU/PIC				0.41	0.41	1.66
SD/CON					0.00	1.24
VBL						1.24
TU/CON						
	One Month Transfer on close-to-everyday-experience Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.1	2.1	2.1	2.3	2.3	2.6
NT		4.15*	4.15*	4.98*	4.98*	6.23*
SD/PIC			0.00	0.83	0.83	2.08
TU/PIC				0.83	0.83	2.08
SD/CON					0.00	1.25
VBL						1.25
TU/CON						

* $p < .05$

NT: No-Training
SD/PIC: Self-Discovery and Pictorial
TU/PIC: Tutorial and Pictorial
SD/CON: Self-Discovery and Concrete
VBL: Verbal
TU/CON: Tutorial and Concrete

TABLE 17

TWO-WAY ANALYSIS OF VARIANCE FOR ONE MONTH TRANSFER ON ABSTRACT ITEMS

Source	df	MS	F	p
Methods	1	0.625	0.941	0.338
Materials	1	1.225	1.845	0.183
Interaction	1	0.025	0.038	0.847
Within	36	0.663		

There was no significant interaction between methods and materials, no significant difference between self-discovery and tutorial methods, and no significant difference between concrete and pictorial materials. The same was true for the Immediate Transfer, Ten Days Retention, and Three Weeks Retention Tests, on both the abstract and close-to-every-day-experience forms of item presentation.

Ranking of Group Means, Considering All Eight Posttests Together

Tables 18 and 19 present the means and standard deviations of the treatment conditions from Immediate Transfer to One Month Transfer, in a further attempt to examine some of the unexpected findings of this study.

Although the differences between the mean scores for the various treatment conditions, as indicated by the one-way analyses of variance, were not statistically significant (except for consistent differences with the control group) they are very much in the expected direction. A close examination of the means for the treatment groups using pictorial, verbal, and concrete materials (Table 18) shows that the means for the concrete mat-

TABLE 18

MEANS AND STANDARD DEVIATIONS OF EACH POSTTEST (MATERIALS) FROM IMMEDIATE TRANSFER TO ONE MONTH TRANSFER

	Group					
	Pictorial		Verbal		Concrete	
Posttest	M	S.D	M	S.D	M	S.D
1	1.7	0.733	2.0	0.943	2.1	0.788
2	2.0	0.858	2.3	0.823	2.3	0.801
3	1.8	0.786	2.2	0.789	2.1	0.852
4	2.1	0.887	2.3	0.823	2.4	0.813
5	1.7	0.733	2.0	0.943	2.1	0.788
6	2.2	0.813	2.4	0.843	2.4	0.754
7	2.0	0.858	2.2	0.919	2.4	0.745
8	2.1	0.852	2.3	0.823	2.5	0.759

TABLE 19

MEANS AND STANDARD DEVIATIONS OF EACH POSTTEST (METHODS) FROM IMMEDIATE TRANSFER TO ONE MONTH TRANSFER

	Group					
	Self-Discovery		Verbal		Tutorial	
Posttest	M	S.D	M	S.D	M	S.D
1	1.8	0.716	2.0	0.943	2.1	0.826
2	2.1	0.887	2.3	0.823	2.3	0.786
3	1.9	0.875	2.2	0.789	2.0	0.795
4	2.1	0.912	2.3	0.823	2.3	0.801
5	1.8	0.716	2.0	0.943	2.1	0.826
6	2.2	0.834	2.4	0.843	2.4	0.745
7	2.1	0.826	2.2	0.919	2.3	0.801
8	2.2	0.834	2.3	0.823	2.4	0.813

erial group are always higher than the means for the pictorial group. Expectation 1c. that subjects who are trained using concrete materials will perform at a higher level than subjects using pictorial materials seems to be met by an examination of these means.

Similarly, an examination of the means for the treatment groups using self-discovery and tutorial methods (Table 19) shows that the means for the tutorial method group are always higher than the means for the self-discovery group. Expectation 1d. that subjects who are trained using tutorial methods will demonstrate a higher performance level than subjects trained using self-discovery methods seems to be met by an examination of these means.

It may be noted that the verbal group means are generally high and in some instances equal to the means for the concrete and tutorial groups. It is also of interest that the means of the "close-to-everyday-experience" items are always higher than the means of the "abstract" items.

To examine the statistical significance of some of these seeming rank-order differences of means when all eight posttests are considered together, Friedman analysis of variance by ranks was used (Ferguson, 1976) with the data of Tables 18 and 19. The control group was omitted from these analyses since the one-way analyses of variance had already shown its means to be consistently below those of the other treatment groups, at high levels of significance. In this context the Friedman analysis of variance by ranks may be viewed as examining the statistical significance of the differences in the ranks of the means of the treatment groups as assigned by the eight posttests, as judges of the treatments. It must be noted that here, strictly speaking, the conditions for use of the Friedman test are not met. As judges of the treatments the eight posttests are not independent, and since they are correlated this will tend to spuriously lower the obtained probabilities. However, if the obtained probabilities are very low, such findings give some confidence that the rankings of the treatment groups do differ significantly at a higher (unknown) level of probability.

Table 20 shows the ranks assigned by the eight posttests to the means of the treatment groups (materials). For these data the Friedman analysis of variance by ranks gives a chi-square of 13.00 ($.001 < p < .01$). The experimental conditions are exerting a significant effect, in particular concrete materials are superior to pictorial materials. The corresponding coefficient of concordance W (Ferguson, 1976; Siegel, 1956) is .813 ($.001 < p < .01$). This highly significant W indicates that the best estimate of the "true" ranking of the three materials is provided by the order of the sums of ranks, here concrete, verbal, pictorial with concrete best.

Table 21 shows the ranks assigned by the eight posttests to the means of the treatment groups (methods). For these data the Friedman analysis of variance by ranks gives a chi-square of 12.56 ($.001 < p < .01$). In particular tutorial methods are superior to self-discovery methods. The corresponding coefficient of concordance W is .790 ($.001 < p < .01$).

A very similar result holds true when the means of the treatment groups using a crossing of materials and methods are examined; over the eight posttests the means for the group that combines concrete materials with tutorial methods are always higher than the means of the groups that combine pictorial materials with self-discovery methods.

Table 22 shows the ranks assigned by the eight posttests to the means of the treatment groups (methods crossed with materials). For

TABLE 20

RANKS ASSIGNED BY POSTTESTS TO MEANS OF TREATMENT GROUPS (MATERIALS)

	Group		
Posttest	Pictorial	Verbal	Concrete
1	3	2	1
2	3	1.5	1.5
3	3	1	2
4	3	2	1
5	3	2	1
6	3	1.5	1.5
7	3	2	1
8	3	2	1
Sum of Ranks	24	14	10

TABLE 21

RANKS ASSIGNED BY POSTTESTS TO MEANS OF TREATMENT GROUPS (METHODS)

	Group		
Posttest	Self-Discovery	Verbal	Tutorial
1	3	2	1
2	3	1.5	1.5
3	3	1	2
4	3	1.5	1.5
5	3	2	1
6	3	1.5	1.5
7	3	2	1
8	3	2	1
Sum of Ranks	24	13.5	10.5

TABLE 22

RANKS ASSIGNED BY POSTTESTS TO MEANS OF TREATMENT GROUPS (MATERIALS AND METHODS)

	Group*				
Posttest	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
1	5	4	3	2	1
2	5	4	3	2	1
3	5	4	3	1.5	1.5
4	5	4	3	2	1
5	5	4	3	2	1
6	5	4	3	2	1
7	5	4	2.5	2.5	1
8	5	4	2.5	2.5	1
Sum of Ranks	40	32	23	16.5	8.5

* SD/PIC: Self-Discovery and Pictorial
TU/PIC: Tutorial and Pictorial
SD/CON: Self-Discovery and Concrete
VBL: Verbal
TU/CON: Tutorial and Concrete

these data the Friedman analysis of variance by ranks gives a chi-square of 30.88 ($p < .001$). In particular the tutorial/concrete group is much superior to the self-discovery/pictorial group. The corresponding coefficient of concordance W is .984 ($p < .001$).

Summary

The training program employing concrete, pictorial, and verbal materials, and self-discovery and tutorial methods, was effective in inducing class inclusion within a period of one month. Significant differences were obtained between all the treatment groups and the control group using the various materials and methods. The significant differences provided a clear indication that the variety of materials and methods used facilitated subjects' understanding and performance on the posttests from Immediate Transfer to One Month Transfer of Class Inclusion. In general subjects who participated in the training sessions substantially increased their scores while the scores of the no-training subjects remained relatively unchanged.

It was expected that significant differences would be found among the various training methods and materials. However, when each posttest was considered separately as a dependent variable, one-way analyses of variance showed no statistically significant differences among the means of the treatment groups (materials), except that all treatment groups were consistently superior to the control group. Similarly, there were no statistically significant differences among the treatment groups (methods).

But, when all eight posttests were considered together as dependent variables, there were consistent differences among the treatment groups (materials) as the means for the groups were ranked by the eight tests, even when the control group was omitted. Specifically, concrete materials were consistently superior to pictorial materials. Similarly, tutorial methods were consistently superior to self-discovery methods. Friedman analyses of variance by ranks showed the difference among methods and among materials to be highly statistically significant, but lack of independence of the posttests makes the actual probabilities for these differences uncertain.

CHAPTER SEVEN

ANALYSES III : OMITTING JUSTIFICATION QUESTION

Rationale for Omitting Justification Question

Studies concerning Piagetian concepts in the western countries have contended that children's explanations of the responses they make are crucial to their understanding and discovery of the concept under investigation. In recent studies concerning cognitive variables in other non-western cultures, researchers have found that it might be more detrimental than beneficial to ask children to justify their answers. Studies have also found that in some instances when a child can correctly and consistently make a judgment or a prediction as to the outcome of a certain transformation of objects, this may be sufficient indication of their understanding of the concept.

In cross-cultural situations, asking someone to further explain a statement which they have made may be considered rude and unrespectful, especially when the age and social status of the participants are taken into consideration. If the participants were there from the beginning of the conversation, they are expected to get the meaning of what is said from the context. For this reason, countersuggestions and further questions may also suggest a riddle with a hidden meaning or provoke an aggressive challenge, if the subject has cause to believe that the questioner already knows the answer. The researcher in cross-cultural settings must constantly be aware of the system of conventionalized meanings and in the context of a different language discern the important features of the stimuli found in a particular environment, which may be functionally more important for that environment, than for his own.

As indicated in Chapter Two of this study, cross-cultural investigations have raised serious doubts concerning the assumptions made about children's correct and incorrect responses in dealing with cognitive variables. Dasen (1972, 1974) and Kiminyo (1973) have cautioned about making the justification question a requirement for showing evidence of understanding a cognitive concept in non-western cultures.

With these considerations in mind, two of the questions of this study re Ten Days Retention and One Month Transfer were analyzed leaving out the justification question. It is expected that the results of the present study will be used to make comparisons with findings from Phase II of this study, which is to be carried out in a non-western culture. These two questions were selected for analysis as it is more likely that the materials and items used here will be used in Phase II replication study.

Method of Scoring

The subjects' responses were scored leaving out the explanations given. For the Ten Days Retention Test for example:

No Score - 1 or 0 correct responses
Partial Score - 2 or 3 correct responses
Full Score - 4 correct responses

This scoring procedure was then translated to the 3-category procedure giving the following criteria:

1 - No understanding of class inclusion

2 - Partial understanding of class inclusion

3 - Full understanding of class inclusion

The meaning of each of these criteria is provided in Appendix E.

Summary of One-Way Analyses of Variance

One-Way Analysis of Variance was used to test the significance of the differences between the means obtained by subjects in the Ten Days Retention and the One Month Transfer tests. The F statistic was used to compare the relative effectiveness of materials, methods, and materials crossed with methods, on the abstract and close-to-everyday-experience posttests.

Summaries of the One-Way Analyses of Variance for Ten Days Retention and One Month Transfer of Class Inclusion are presented in Table 23 (materials), Table 24 (methods), and Table 25 (materials crossed with methods). Overall significant F ratios were obtained ($p < .01$) for materials, methods, and materials crossed with methods for each of the two posttests.

Newman-Keuls Multiple Comparisons of Means

Since significant overall F ratios were obtained in the One-Way Analyses of Variance, the studentized range statistic (Newman-Keuls Method) was used to make comparisons between pairs of means. The means were rank ordered from low to high and the studentized ranges were obtained for all pairs of means. Criterion values of Q for comparing two means were set at the .05 level. The following analyses used these Q values to examine questions 2 and 4 guiding this study.

TABLE 23

SUMMARY OF ONE-WAY ANALYSES OF VARIANCE (MATERIALS) FOR TEN DAYS RETENTION AND ONE MONTH TRANSFER

Variable	df	MS	F	p
Ten Days Retention on Abstract Items	3	3.61	6.29**	0.0009
	56	0.57		
Ten Days Retention on Close-to-everyday-experience Items	3	3.61	6.45**	0.0008
	56	0.56		
One Month Transfer on Abstract Items	3	3.81	6.76**	0.0006
	56	0.56		
One Month Transfer on Close-to-everyday-experience Items	3	3.81	6.37**	0.0009
	56	0.60		

** $p < .01$

TABLE 24

SUMMARY OF ONE-WAY ANALYSES OF VARIANCE (METHODS) FOR TEN DAYS RETENTION AND ONE MONTH TRANSFER

Variable	df	MS	F	p
Ten Days Retention on Abstract Items	3	3.28	5.54**	0.002
	56	0.59		
Ten Days Retention on Close-to-everyday-experience Items	3	3.48	6.13**	0.001
	56	0.57		
One Month Transfer on Abstract Items	3	3.61	6.29**	0.0009
	56	0.57		
One Month Transfer on Close-to-everyday-experience Items	3	3.64	6.00**	0.001
	56	0.61		

** $p < .01$

TABLE 25

SUMMARY OF ONE-WAY ANALYSES OF VARIANCE (MATERIALS CROSSED WITH METHODS) FOR TEN DAYS RETENTION AND ONE MONTH TRANSFER

Variable	df	MS	F	p
Ten Days Retention on Abstract Items	5 54	2.22 0.59	3.75**	0.005
Ten Days Retention on Close-to-everyday-experience Items	5 54	2.22 0.58	3.85**	0.005
One Month Transfer on Abstract Items	5 54	2.42 0.57	4.22**	0.003
One Month Transfer on Close-to-everyday-experience Items	5 54	2.39 0.61	3.91**	0.004

** $p < .01$

II Ten Days Retention of Class Inclusion

The second guiding question in this study that subjects exposed to a training program through concrete, pictorial, and verbal materials will retain their acquired learning over a Ten-Days period when tested on the same materials, and that subjects in the control group will not change significantly was supported in a comparison of pairs of means between the treatment groups and the control group. Separate tests on the Ten Days Retention Test data were carried out for concrete, pictorial, verbal, and no-training materials, using the abstract and close-to-everyday-experience items.

1. Materials: Table 26 presents the values of Q for the ordered means obtained on the Ten Days Retention Test using various materials. Significant differences were obtained between the means of the trained sub-

jects using concrete, pictorial, and verbal group means and the means of the subjects in the control group. No significant differences were detected when means of the treatment groups were compared among themselves.

TABLE 26

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS) FOR TEN DAYS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Ten Days Retention on Abstract Items					Ten Days Retention on Close-to-everyday-experience Items				
	NT	P	C	V		NT	P	C	V
MEANS	1.1	2.0	2.3	2.3	MEANS	1.2	2.2	2.4	2.4
NT		4.10*	5.78*	5.78*	NT		4.64*	5.86*	5.86*
P			1.69	1.69	P			1.22	1.22
C				0.00	C				0.00
V					V				

* $p < .05$ NT: No-Training; P: Pictorial; C: Concrete; V: Verbal

These data show that the variety of materials employed facilitated subjects' retention of class inclusion over a Ten-Days period. Expectation 1a. of this study was supported. This is the same conclusion reached when subjects' scores with justification were used.

2. Methods: To test the question that subjects exposed to a training program through self-discovery, tutorial, and verbal methods will retain their learning over a Ten-Days period, while the control group will not change significantly, a comparison of pairs of means between the treat-

ment groups and the control group was made. This question was supported by significant differences obtained between the means of the trained subjects using these methods and the means of the subjects in the control group.

Table 27 presents the values of Q for the ordered means obtained on the Ten Days Retention Test using various methods.

TABLE 27

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (METHODS) FOR TEN DAYS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Ten Days Retention on Abstract Items					Ten Days Retention on Close-to-everyday-experience Items				
	NT	SD	TU	V		NT	SD	TU	V
MEANS	1.1	2.1	2.2	2.3	MEANS	1.2	2.2	2.4	2.4
NT		4.51*	5.22*	5.70*	NT		4.85*	5.58*	5.82*
SD			0.71	1.19	SD			0.73	0.97
TU				0.47	TU				0.24
V					V				

* $p < .05$ NT: No-Training; SD: Self-Discovery; TU: Tutorial; V: Verbal

These data show that these methods facilitated subject's retention of class inclusion while the control group showed little change. Expectation 1b. of this study was supported. The same conclusion as when scores with justification were used, was arrived at.

3. Materials Crossed with Methods: A test of the Ten Days Retention of Class Inclusion question is also provided by a comparison of means obtained between subjects trained using a combination of materials and methods, and means of the control group. Significant differences occurred between each of the treatment conditions and the no-training condition. No significant differences occurred among treatment groups.

Table 28 presents the values of Q for the ordered means obtained on the Ten Days Retention Test using a combination of materials and methods. The combination of materials and methods was found to be facilitative of class inclusion retention. This conclusion is the same as the conclusion arrived at when scores with justification were used.

IV One Month Transfer of Class Inclusion

The fourth guiding question in this study that subjects exposed to a training program through concrete, pictorial, and verbal materials will transfer their acquired learning to a class inclusion test using objects other than the training objects, and that subjects in the control group will not change significantly, received support from a comparison of pairs of means between the treatment groups and the control group. Separate tests on the One Month Transfer Test data were carried out for concrete, pictorial, verbal, and no-training materials, using the abstract and close-to-everyday-experience items.

1. Materials: Table 29 presents the values of Q for the ordered means obtained on the One Month Transfer Test using various materials. Significant differences were obtained between the means of the trained subjects using concrete, pictorial, and verbal materials and the means of the control group. No significant differences were detected between the means of the treatment groups themselves.

TABLE 28

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS AND METHODS) FOR TEN DAYS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

	Ten Days Retention on Abstract Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.1	1.9	2.0	2.2	2.3	2.4
NT		3.29*	3.70*	4.53*	4.94*	5.35*
SD/PIC			0.41	1.23	1.65	2.06
TU/PIC				0.82	1.23	1.65
SD/CON					0.41	0.82
VBL						0.41
TU/CON						

	Ten Days Retention on Close-to-everyday-experience Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.2	2.1	2.2	2.3	2.4	2.5
NT		3.75*	4.17*	4.58*	5.00*	5.42*
SD/PIC			0.42	0.83	1.25	1.67
TU/PIC				0.42	0.83	1.25
SD/CON					0.42	0.83
VBL						0.42
TU/CON						

* $p < .05$

NT: No-Training
SD/PIC: Self-Discovery and Pictorial
TU/PIC: Tutorial and Pictorial
SD/CON: Self-Discovery and Concrete
VBL: Verbal
TU/CON: Tutorial and Concrete

TABLE 29

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS) FOR ONE MONTH TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

One Month Transfer on Abstract Items					One Month Transfer on Close-to-everyday-experience Items				
	NT	P	V	C		NT	P	V	C
MEANS	1.1	2.0	2.3	2.4	MEANS	1.2	2.2	2.4	2.5
NT		4.38*	5.84*	6.08*	NT		4.49*	5.67*	5.90*
P			1.46	1.70	P			1.18	1.42
V				0.24	V				0.24
C					C				

* $p < .05$ NT: No-Training; P: Pictorial; V: Verbal; C: Concrete

These data show that within one month, the trained subjects were able to transfer their class inclusion learning to a test using the same materials but objects other than training objects. The same conclusion was reached when scores with justification were used.

2. Methods: A test of the question that subjects exposed to a training program through self-discovery, tutorial, and verbal methods will transfer their learning within one month to a class inclusion test using objects other than training objects, and that subjects exposed to no-training methods will be unable to do so, is provided by a comparison of means obtained between the treatment groups and the control group. Significant differences obtained between the means of the trained subjects using these methods and the means of the control group provide support for

this question. No significant differences occurred among treatment groups.

Table 30 presents the values of Q for the ordered means obtained on the One Month Transfer Test using various methods.

TABLE 30

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (METHODS) FOR ONE MONTH TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

One Month Transfer on Abstract Items					One Month Transfer on Close-to-everyday-experience Items				
	NT	SD	TU	V		NT	SD	TU	V
MEANS	1.1	2.1	2.3	2.3	MEANS	1.2	2.2	2.4	2.4
NT		4.58*	5.78*	5.78*	NT		4.69*	5.65*	5.62*
SD			1.20	1.20	SD			0.94	0.94
TU				0.00	TU				0.00
V					V				

* $p < .05$ NT: No-Training; SD: Self-Discovery; TU: Tutorial; V: Verbal

These data indicate that the methods used facilitated subjects' transfer of learning to a test using objects other than training objects, while there was little change in the control group. This conclusion is the same as the conclusion reached when scores with justification were used.

3. Materials Crossed with Methods: A test of the One Month Transfer of Class Inclusion question is also provided by a comparison of means obtained between subjects trained using a combination of materials

and methods, and means of the control group. Significant differences were obtained between each of the treatment conditions and the no-training condition. No significant differences occurred when comparisons were made between the treatment group means.

Table 31 presents the values of Q for the ordered means obtained on the One Month Transfer Test using a combination of materials and methods, on the abstract and close-to-everyday-experience items. These data indicate that within a period of one month, trained subjects were able to transfer their class inclusion learning using a combination of materials and methods while the control group did not change significantly. The same conclusion was reached when scores with justification were used.

Two-Way Analyses of Variance

Two-Way Analysis of Variance was used to test the significance of the differences between the means on each of the two posttests. Means obtained by subjects trained on self-discovery and tutorial methods, and means obtained using concrete and pictorial materials were used for these analyses. This test also sought to find out whether any significant interaction effects existed among methods and materials.

In illustration, Table 32 presents results of the two-way analysis of variance for the One Month Transfer Test on Close-to-everyday-experience Items.

TABLE 31

Q VALUES OF THE STUDENTIZED RANGE STATISTIC (MATERIALS AND METHODS) FOR ONE MONTH TRANSFER ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

	One Month Transfer on Abstract Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.1	1.9	2.1	2.2	2.3	2.5
NT		3.34*	4.18*	4.60*	5.02*	5.85*
SD/PIC			0.84	1.25	1.67	2.51
TU/PIC				0.42	0.84	1.67
SD/CON					0.42	1.25
VBL						0.84
TU/CON						

	One Month Transfer on Close-to-everyday-experience Items					
	NT	SD/PIC	TU/PIC	SD/CON	VBL	TU/CON
MEANS	1.2	2.1	2.2	2.3	2.4	2.6
NT		3.64*	4.05*	4.45*	4.85*	5.66*
SD/PIC			0.40	0.81	1.21	2.02
TU/PIC				0.40	0.81	1.62
SD/CON					0.40	1.21
VBL						0.81
TU/CON						

* $p < .05$

NT: No-Training
SD/PIC: Self-Discovery and Pictorial
TU/PIC: Tutorial and Pictorial
SD/CON: Self-Discovery and Concrete
VBL: Verbal
TU/CON: Tutorial and Concrete

TABLE 32

TWO-WAY ANALYSIS OF VARIANCE FOR ONE MONTH TRANSFER ON CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS

Source	df	MS	F	P
Methods	1	0.400	0.576	0.452
Materials	1	0.900	1.296	0.262
Interaction	1	0.099	0.144	0.706
Within	36	0.694		

There was no significant interaction between methods and materials, no significant difference between self-discovery and tutorial methods, and no significant difference between concrete and pictorial materials.

The same finding was obtained when scores with justification were used.

Ranking of Group Means, Considering All Four Posttests Together

Tables 33 and 34 present the means and standard deviations of the treatment conditions for the Ten Days Retention and One Month Transfer tests, in a further attempt to examine some of the unexpected findings of this study.

Although the differences between the mean scores for the various treatment conditions, as indicated by the one-way analyses of variance, were not statistically significant (except for consistent differences with the control group) they are very much in the expected direction. A close examination of the means for the treatment groups using pictorial, verbal, and concrete materials (Table 33) shows that the means for the concrete material group are always higher than the means for the pictorial group. Expectation 1c. that subjects who are trained using concrete materials will perform at a higher level than subjects using pictorial materials seems to be met by an examination of these means.

Similarly, an examination of the means for the treatment groups using self-discovery and tutorial methods (Table 34) shows that the means for the tutorial method group are always higher than the means for the self-discovery group. Expectation 1d. that subjects who are trained using tutorial methods will demonstrate a higher performance level than subjects trained using self-discovery methods seems to be met by an examination of these means.

It may be noted that the verbal group means are generally high and in some instances equal to the means for the concrete and tutorial groups. It is also of interest that the means of the "close-to-everyday-experience" items are always higher than the means of the "abstract" items.

TABLE 33

MEANS AND STANDARD DEVIATIONS OF TEN DAYS RETENTION AND ONE MONTH TRANSFER (MATERIALS)

	Group					
	Pictorial		Verbal		Concrete	
Posttest	M	S.D	M	S.D	M	S.D
3	2.0	0.887	2.3	0.823	2.3	0.733
4	2.2	0.813	2.4	0.843	2.4	0.754
7	2.0	0.858	2.3	0.823	2.4	0.745
8	2.2	0.875	2.4	0.843	2.5	0.759

TABLE 34

MEANS AND STANDARD DEVIATIONS OF TEN DAYS RETENTION AND ONE MONTH TRANSFER (METHODS)

	Group					
	Self-Discovery		Verbal		Tutorial	
Posttest	M	S.D	M	S.D	M	S.D
3	2.1	0.826	2.3	0.823	2.3	0.834
4	2.2	0.834	2.4	0.843	2.4	0.745
7	2.1	0.826	2.3	0.823	2.3	0.801
8	2.2	0.834	2.4	0.834	2.4	0.821

Comparison of Scoring With and Without Justification

Using scores without justification to analyze the responses of the treatment conditions, the same conclusions were reached as when scores with justification were used. Expectation 2, that the performance of subjects who justify their responses will not differ significantly from the performance of subjects who do not justify their responses was supported. This finding provides further support for the findings reported by Dasen (1974) and Kiminyo (1973), that the performance of subjects who justified their responses did not differ significantly from the performance of subjects who did not justify their responses, and that this criterion does not change the quality of the concept under investigation.

Table 35 presents a comparison of Q values obtained for Ten Days Retention on abstract and close-to-everyday-experience items (materials) for scores with and without justification. No practical differences arise from this comparison between the ranking of means scored in two different ways.

TABLE 35

COMPARISON OF Q VALUES (MATERIALS) FOR TEN DAYS RETENTION ON ABSTRACT AND CLOSE-TO-EVERYDAY-EXPERIENCE ITEMS FOR SCORES WITH AND WITHOUT JUSTIFICATION

(With Justification)

Ten Days Retention on Abstract Items					Ten Days Retention on Close-to-everyday-experience Items				
	NT	P	C	V		NT	P	V	C
MEANS	1.0	1.8	2.1	2.2	MEANS	1.1	2.1	2.3	2.4
NT		3.67*	5.39*	5.88*	NT		4.42*	5.58*	5.82*
P			1.71	2.20	P			1.16	1.40
C				0.49	V				0.23
V					C				

(Without Justification)

Ten Days Retention on Abstract Items					Ten Days Retention on Close-to-everyday-experience Items				
	NT	P	C	V		NT	P	C	V
MEANS	1.1	2.0	2.3	2.3	MEANS	1.2	2.2	2.4	2.4
NT		4.10*	5.78*	5.78*	NT		4.64*	5.86*	5.86*
P			1.69	1.69	P			1.22	1.22
C				0.00	C				0.00
V					V				

* $p < .05$ NT: No-Training; P: Pictorial; C: Concrete; V: Verbal

The similarity of the upper and lower halves of Table 35 concerned with Ten-Days Retention, is striking. The same conclusions are reached, whether scoring is done with justification or without justification. The

One-Month Transfer data again provided the same conclusions, whether scoring was done with justification or without justification.

An inspection of the Q values and the ranks of the ordered means reveals that the differences between the groups increases with the particular material (concrete) or method (tutorial) used for both justification and non-justification scores. It may be noted that the verbal group means are generally high and in some instances equal to the means for the concrete group in the two methods of scoring.

Summary

Using scores without justification, the training program employing concrete, pictorial, and verbal materials, and self-discovery and tutorial methods, was effective in inducing class inclusion. Significant differences were obtained between the treatment groups and the control group using the various materials and methods, for the Ten Days Retention and One Month Transfer tests. This finding provides a clear indication that the variety of materials and methods used facilitated subjects' understanding and performance on the Class inclusion posttests. Since there was little change in the performance of the control group, the differences in the mean scores of the treatment groups and the control group were attributed to the training. The high level of performance between the trained groups (materials) and (methods) as compared to the control group provided support for the expectations of this study.

The main point of this chapter however, is that scoring without justification has provided the same conclusions as scoring with justification.

CHAPTER EIGHT

SUMMARY, DISCUSSION, AND IMPLICATIONS

Summary and Discussion of Findings

The main purposes of this study were: (1) to investigate the effectiveness of training methods and materials in the acquisition of the class inclusion concept among five- and six-year old kindergarten and grade one children; (2) to examine the nature of young children's understanding, retention, and transfer of this logical ability and (3) to examine the results in light of a cross-cultural framework which may have potential in interpreting responses from children in a different culture, socioeconomic level or simply a different setting.

This study was based largely on the theoretical rationale of Jean Piaget and was concerned with the extension of one of the most important aspects of classification re class inclusion and its relation to modes of reasoning using a variety of materials and methods.

Significant points arising from a consideration of the results of this study are summarized and discussed below.

Possibility of Training

A major finding of this study is that the acquisition of class inclusion can be accelerated through training. Five- and six-year old, middle-class, urban, Alberta children were found to perform effectively on class inclusion problems, when the appropriate training techniques were employed and when the appropriate stage of understanding the concepts "all" and "some" had been attained.

This finding provides additional support for the use of training procedures in the acquisition of class inclusion concepts. Subjects who received training were required to have a grasp of the concepts "all" and "some", which is in keeping with the criteria proposed by Inhelder and Piaget (1964) for the operational existence of classes. Using these criteria, the training procedures employed in the present investigation can be viewed as having uncovered a capacity for dealing with class inclusion problems among five- and six-year old children as opposed to having created a capacity *de novo*.

Variety of Materials and Methods

An examination of the results shows that when each posttest was considered separately as a dependent variable, all treatment groups were statistically significantly superior to the control group. However, no statistically significant differences were obtained among treatment groups using different materials or methods.

A closer examination of the results however, shows that when all eight posttests were considered together as dependent variables, concrete materials were consistently superior to pictorial materials and tutorial methods were consistently superior to self-discovery methods.

Subjects in the verbal groups were found to be only slightly under concrete and tutorial groups for these middle-class, urban children.

The above findings indicate that using a variety of materials and methods, the class inclusion skills of kindergarten and grade one children can be activated, in such a way that improvements that are durable and minimally general can be observed. Improvements made by subjects in the training groups may be said to be durable since they continued to be evident one month after training. Improvements may also be said to be minimally general since the stimuli in the Immediate Transfer and One Month Transfer tests were different from the stimuli used in the training.

This finding is similar to that reported by Dasen et al. (1979) who investigated the acquisition of conservation of liquids in West African children. The authors demonstrated that significant training effects could be achieved if (1) a variety of materials as well as of training methods were used; and (2) the flexibility of Piaget's clinical method was exploited.

Piaget (1974) has stated that the child's active manipulation of concrete objects is a necessary part of teaching for intellectual development. In the present investigation, subjects using concrete materials showed a higher level of performance on class inclusion problems than subjects using pictorial materials. This finding verifies Piaget's position that:

> It is absolutely necessary that learners have at their disposal concrete material experiences (and not merely pictures), and that they form their own hypotheses and verify them (or not verify them) themselves through their own active manipulation.
>
> (Piaget, 1974, p. ix-x).

Although Piaget's emphasis that the child's manipulation of concrete material is a necessary (though not sufficient) part of teaching for intellectual development is supported in this study, Jennings (1970), Aldrich (1970), Winer and Kronberg (1974), have shown that the effects of pictorial materials in teaching class inclusion cannot be minimized. The writer is of the opinion that the optimum situation may be to begin instruction with concrete materials and to gradually introduce pictorial representations to permit the child's transition from the immediate perceptual context to more abstract thought levels.

The finding that tutorial procedures are superior to self-discovery procedures in facilitating subjects' understanding of class inclusion provides further support for studies which have shown that contrary to Piaget's emphasis on self-discovery learning, tutorial methods work quite well as training strategies. Brainerd (1974) reported that "... simple feedback which is contingent on judgment responses is an effective procedure for inducing improvements in class inclusion". The evidence concerning the effects of feedback which is provided in tutorial training strategies has also been reported by Kohnstamm (1967), Ahr and Youniss (1970), and Hatano and Kuhara (1972).

The conclusion that seems to follow from a comparison of results among studies employing self-discovery and tutorial methods is that overall, tutorial methods seem to facilitate the understanding of cognitive reasoning skills better than self-discovery methods.

Task Presentation

The present study reveals that young children can be trained to compare part with whole in class inclusion problems if the method of task presentation is amended. When the close-to-everyday-experience form of task presentation was employed in the present study, subjects showed higher levels of performance than when the standard, more abstract form of task presentation was used. Inhelder and Piaget (1964) attributed their finding of significant differences between children's classification of animals and plants, to the fact that the animal classes were more remote from everyday experience and therefore more abstract.

Support for the importance of correct task presentation is also provided in a study by McGarrigle et al. (1978) who compared two forms of task presentation in class inclusion problems. These authors suggested that:

> ... it would seem that the typical form of task presentation encourages the child to assume that the task requires him to compare distinct subsets. It is when this assumption is discouraged, by amending the perceptual or linguistic aspects of the presented information, that the child's performance improves. (p. 459).

These findings indicate that the way class inclusion problems are presented determines how children proceed to make comparisons between part with whole.

The present study has also shown that a change in the wording of the class inclusion question by adding an adjective that qualifies the whole set (e.g. sleeping cows) affects the responses made to that question. With this addition, the challenge to the child's assumption that the inclusion task requires comparison of subclasses is minimized, and in the present study it is accomplished by means of the unusual "sleeping" and "sitting" posture of the cows used in the One Month Transfer of class inclusion test. Thus, a form of the question which defines the subclasses for comparison in terms of the different salient features seems to be of importance.

Verbal Justification Criterion

An important finding of this study is that scoring subjects' responses without verbal justification provides the same conclusions as scoring with verbal justification. This finding gives additional evidence and support to the positions held by Dasen (1974) and Kiminyo (1973) that there are no significant differences in the performance of subjects who justify their responses in cognitive tasks and subjects who do not. Brainerd (1973) also maintains that judgments only, without explanations, should be used to infer the presence or absence of cognitive concepts.

This finding is of particular importance to cross-cultural investigations in which subjects may not be used to giving oral explanations of the responses they make. Subjects might have the concept about which questions are asked but may be reluctant or unable to express it verbally, especially in the presence of an authority figure or an older person. Thus the criterion for the verbal justification of responses may require further investigation.

Conclusion

It should be noted that this study achieves several ends. By showing that five- and six-year old middle-class, urban, Alberta children, with an initial understanding of "all" and "some" can be trained to perform on class inclusion problems, the study lends support to the Piagetian position that, "acceleration of learning is possible if the more complex structure is based on simpler structures". By showing that a variety of techniques used in the training are crucial to children's understanding, retention, and transfer of class inclusion, the study makes a contribution to class inclusion acceleration studies which have heretofore been inconclusive about training techniques. By showing that the young child can be trained to succeed on class inclusion problems if the task presentation is amended, the study identifies a need to specify an interpretation of the child's typical behaviour in standard presentations of the problem alternative to that of Piaget. By showing that scoring without justification provides the same conclusions as scoring with justification, the study provides additional information which can be used in interpreting responses of children from a different culture or background. Overall, the study provides pointers to the directions in which future research in class inclusion problems should be focused.

Implications of Findings

The design of the study restricts the generalizability of the findings to comparable groups of five- and six-year old children who are in their first year of kindergarten and grade one classes. A second limitation arises from the restriction of the data to urban, middle-class children from a single culture. With these limitations in mind, the findings of this study are examined for their implications for theory, practice, and research.

1. Implications for Theory

The results of this study support the contention that the acquisition of class inclusion among five- and six-year old children can be accelerated if the appropriate training techniques are employed and if the appropriate stage of understanding "all" and "some" has been reached. In Piaget's standard class inclusion problem, the child is required to compare a whole with one of its parts. For example, the child is shown a number of wooden beads, most of which are brown, but two of which are white, and asked whether there are more wooden beads or more brown beads. Since children aged below 7 or 8 years, typically fail this problem, Piaget's view is that the younger preoperational child cannot make the simultaneous comparison of part with whole and is instead limited to comparing one part with another in inclusion problems. This study shows that training helps to alleviate this problem.

This study provides evidence that the abstract form of the class inclusion question is more difficult for children than the close-to-everyday-experience form of the question. Wohlwill (1968) notes that, "even to an adult there appears something slightly tricky about such questions as "Are there more pears or more fruit?". The or is interpreted exclusively rather than inclusively because that is its overwhelmingly more common usage". (p.462). Children in the present study were shown to improve their solutions of class inclusion problems with tasks appropriate to their often limited linguistic capacity and comprehension of relational terms such as "more".

Although it is not Piagetian to believe that verbally transmitted rules and explanations may cause a child to reason logically for himself, subjects in the verbal training groups of this study performed almost as well as subjects in the other groups, and in some instances their mean scores were as high as the mean scores of the tutorial and concrete groups.

The training techniques used in this study helped to reveal subjects' competence of class inclusion which was evident in their performance of class inclusion problems. This finding is in line with Piaget's opinion that development cannot be reduced to a series of bits of learning and "... the notion of competence has to be introduced as a precondition for any learning to take place". (Piaget, 1974).

The Piagetian tradition requires that children should verbalize explanations of the responses they make after cognitive concepts have been trained. In Piagetian terms, a child has not acquired the trained concept unless justifications have been made. The findings of this study show that there are no significant differences between justifiers and non-justifiers. There is adequate evidence from cross-cultural research that justification of one's responses is not necessarily a prerequisite to understanding the concept that is trained.

2. Implications for Practice

A central problem for educators today is the development of appropriate intervention procedures to assist the child in concept development. Consequently, this study attempted to delineate some of the variables which might influence or help to accelerate the acquisition of class inclusion.

It is reasonable, for instance, to expect that in teaching class inclusion a combination of techniques and an abundance of attractive materials should be used not only to provide variety but also to maximize the likelihood of provoking some experiences which would be productive for a particular child. The choice of specific teaching materials and methods would however, be governed by the teacher's assessment of the child's current cognitive level. Such information may be obtained through a close relationship between the teacher and the child, fostered in a Piagetian clinical method.

Use of diverse teaching techniques is suggested here because the child's life is a complicated blending of instruction and discovery. While many facts will be handed down to the child, he will at the same time be engaged in inductive reasoning, the process of bringing together a number of experiences and extracting from them some common factor. The issue then becomes not instruction versus discovery, since both are essential, but a consideration of the relative importance to be accorded each in the educational process.

This study suggests that for young children, the curriculum should be such that it provides adequate stimulation of a sufficiently diverse and attractive nature and which permits maximal individual exploration. In addition, young children should be provided with explicit feedback concerning the effectiveness or degree of accuracy of their responses within any learning sequence.

From a practical point of view, the self-discovery method on its own may be difficult for teachers because they may find it hard to suppress a natural tendency to reinforce as well as to direct the learning experiences of children. This is why it is suggested that a combination of tutorial and self-discovery techniques may be more efficacious in teaching young children.

To induce the development of the structures essential to solving class inclusion tasks, it is suggested that children should be encouraged to carry out many activities in the classroom setting in which they are actively engaged in actual concrete manipulation of the objects or task materials in question. Situations should be provided in which they combine subclasses to make a class and break a class down into its subclasses. As they transform these things, they should answer questions about the various classes, that is, questions which force the child to think about groupings that he is composing and comparing. Followup activities should be organized with different materials, such that the principle of variety, deemed essential to generalization and transfer, is adequately provided for.

Piaget's most important assumption is that all knowledge is derived from action which the child performs on objects and then organizes in his brain. Since young children cannot learn by sitting passively in their seats, there should be provision for a wide variety of activities in the classroom, for example, extensive play areas with a wide variety of toys and games to be used in grouping, counting, classifying, sorting and various kinds of construction. In this regard, materials should be carefully selected so as to give experiences for as much representation and construction as possible. To assist in cognitive organization, these activities should also include exploring and discovering the properties of objects, materials and living things, including taking things apart and putting them back together.

In the home setting, parents can emphasize real experiences for their young children. A trip to the pet store can be utilized in assisting the child's learning about various animals. The grocery store is a good place to point out and name various fruits and vegetables.

In summary, the following statement by Inhelder (from Bruner, 1960, p.46) seems appropriate:

> One wonders in the light of all this whether it might not be interesting to devote the first two years of school to a series of exercises in manipulating, classifying and ordering objects in ways that highlight basic operations of logical addition, multiplication, inclusion, serial ordering and the like. For surely these logical operations are the basis of more specific operations and concepts of all mathematics and science. It may indeed be the case that such an early science and mathematics "precurriculum" might go a long way toward building up in the child the kind of intuitive and more inductive understanding that could be given embodiment later in formal courses in mathematics and science. The effect of such an approach would be to put more continuity into science and mathematics and also give the child a much better and firmer comprehension of the concepts which unless he has this early foundation, he will mouth later without being able to use them in any effective way. (p.46).

Overall, the ability to classify objects, events and situations is recognized as a salient cognitive operation and a necessary basis for organizing a person's environment in all areas of the experiences of life. Although this ability is universal to all people, the skills to classify in multiple relationships is especially imperative today. For today, the child finds himself in a complex technological world. That is a world of abstractions and symbolizations on the one hand, and a world of materialistic object bombardment on the other hand. Thus the ability to classify and order both concrete objects and events as well as abstract ideas and values becomes a necessity. In our present society, the development of a skill as important as classification cannot be left to chance. Children need to be offered the opportunity to develop cognitive organizations to cope with the realities of a changing world.

3. Implications for Research

In Chapter One, reference was made to examining the results of this study "in light of a cross-cultural framework from children in a different culture, socioeconomic level or simply a different setting". Since the writer is from Kenya, and deeply committed to the development of Kenyan children and Kenyan society, her hope was that this study would clarify some basic issues with regard to training in class inclusion, and that this clarification would enable the writer to plan research which would facilitate the acquisition of class inclusion in Kenyan children.

The following basic issues appear to have been sufficiently clarified:

1. The acquisition of class inclusion can be accelerated provided that (a) children have attained an understanding of the concepts "all" and "some"; and (b) the training methods include a variety of materials, a variety of teaching modes, and exploitation of the flexibility inherent in the Piagetian clinical method.

2. The verbal justification criterion for attainment of class inclusion is not necessary.

To what extent are such findings generalizable to populations of a different age, culture, and society such as older Kenyan children in a rural environment, with limited access to school education? The findings of this study as just stated in the most general and formal way, can now help us search for the specific conditions under which class inclusion is acquired, and can be accelerated in children of a different age, culture, and society.

For Phase II of this study, the writer will examine these basic issues and go beyond this by using a language that children in the Kenyan environment understand and, using local and indigenous materials with which subjects are familiar. These factors will help to unearth reasons for failure on first testing and establish rapport. (Appendix G).

The present study has also given rise to a number of important questions which might be profitably explored in future research.

1. How can the procedures employed in this study be used to improve subjects' performance in tests on cognitive variables in a cultural setting where access to schooling is limited?

   The use of a variety of training techniques is suggested as one approach to this problem and also making use of local talent i.e. research assistants from the culture under investigation.

2. Should the various materials be introduced at the same time or at different times?

   Depending on the nature of the subjects of the study, some materials (concrete) may be introduced first, while other materials (pictorial) may be gradually introduced. Familiarity of materials is a major factor.

3. For how long should the training sessions last if the learning process is to be effective?

   Training could be broken into several sessions and extend over a period of two or three weeks in order to get a good assessment of the processes of learning.

4. What sample size of subjects can be adequately trained and tested?

   This depends on the purposes of the study and on the constraints in time that might be present.

5. Does training in class inclusion assist subjects to transfer their learning to other logical reasoning concepts?

   This question can be approached by including a concept in a different field (e.g. conservation) but of the same level as the concept that was the object of the learning sessions.

The answers to these questions imply a careful sequencing of the processes that children go through in learning class inclusion skills, which should serve as diagnostic tools to guide the investigator in determining the level at which training could be initiated.

In cross-cultural settings, emphasis must be made on the use of a wide range of concrete media in training cognitive skills. Once the fundamental action patterns and organizational skills are mastered, the training program could gradually draw the child away from the explicit concrete material settings to higher representational levels. At this point the use of pictorial representations could be introduced to gradually permit the transition from the immediate perceptual context to abstract thought levels.

The implications of these statements from a cross-cultural perspective direct attention to the educational preparation and professional training of teachers from preschool to high school levels. There is a need to recognize that the inherited system of education is inappropriate to the evolving technical needs and social circumstances of independent Kenya. In a society where belief in the therapeutic potential of education for solving individual and national problems remains strong, educational planning cannot continue to depend so much on decisions made about the development of children elsewhere. The writer is aware of much needed hard data which can guide policy-makers in deciding new choices. She is also aware that faith in the ability of education to solve problems of development remains blind unless it can be attached to an empirical understanding of what kinds of education have what effects under what conditions. This endeavour entails an overall rationale and definition of techniques that reach beyond the confines of the school and encompasses the larger community.

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APPENDIX A

PRETEST I

"ALL" and "SOME"

Materials

4 blue circle blocks

4 red square blocks

4 red circle blocks

4 blue square blocks

Procedure

The stimuli, all oriented in the same direction are placed on the table in front of the subject. The blocks are all mixed up. The subject is asked to verbalize all the attributes distinctive to the classes. Then the following questions are presented:

1. "Look at all the red blocks"

   Are all the red blocks circles?

2. "Look at all the circle blocks"

   Are all the circle blocks red?

3. "Look at all the square blocks"

   Are all the square blocks blue?

4. "Look at all the blue blocks"

   Are all the blue blocks squares?

To pass this task, the subject is required to answer all four questions correctly.

PRETEST II

"BEADS TEST"

Materials

20 round wooden beads

18 brown and 2 white

1 sheet of green paper

2 boxes

Procedure

The subject is presented with a complete set of 20 wooden beads laid out in mixed order on a sheet of green paper. The subject is asked to pick up some of the beads and look at them. Then the following questions are asked:

1. What are these?
2. What are the beads made of?
3. What colour are they?
4. If I put the brown beads in this box, will there be any beads left?
5. If I put the wooden beads in the other box, will there be any beads left?
6. Are there more wooden beads or more brown beads?

If the subject is able to answer both questions (5) and (6) correctly, no further tests are given. The subject does not qualify for training.

APPENDIX B

TRAINING TASKS

GROUP I

Method: Self-discovery

Materials: Concrete

The objects for this task consist of:

Animals:

5 brown toy sheep and 3 white sheep

5 big toy pigs and 3 little pigs

3 brown toy horses and 1 white horse

Vegetables:

3 plastic cobs of corn

1 plastic tomato

Fruits:

3 plastic bananas and 2 pineapples

3 plastic apples and 2 pears

3 plastic oranges and 2 lemons

Procedure

The subject is presented with the above toy plastic objects and asked to name the animals, vegetables and fruits respectively, so as to indicate whether he has some notion of the classes. He is also asked to verbalize the attributes distinctive to the classes and to count the number of objects in each class and in the total class. The subject is allowed to manipulate the objects. The subject is guided so that he understands the relationships between A, A' and B.

During the training session, the following questions are asked.

5 brown sheep and 3 white sheep

Are there more brown sheep or more sheep?

How many brown sheep?

How many white sheep?

How many animals?

Are there more brown sheep or more animals? Why?

5 big pigs and 3 little pigs

Are there more big pigs or more pigs?

How many big pigs?

How many little pigs?

How many animals?

Are there more big pigs or more animals? Why?

3 brown horses and 1 white horse

Are there more brown horses or more horses?

How many brown horses?

How many white horses?

How many animals?

Are there more brown horses or more animals? Why?

5 brown sheep and 3 brown horses

Are there more brown sheep or more animals?

How many sheep?

How many horses?

How many animals?

Are there more brown sheep or more animals? Why?

3 cobs of corn and 1 tomato

Are there more cobs of corn or more things to eat?

How many cobs of corn?

How many tomatoes?

How many vegetables?

Are there more cobs of corn or more vegetables? Why?

3 bananas and 2 pineapples

Are there more bananas or more things to eat?

How many bananas?

How many fruits?

Are there more bananas or more fruits? Why?

3 apples and 2 pears

Are there more apples or more things to eat?

How many apples?

How many pears?

How many fruits?

Are there more apples or more fruits? Why?

3 oranges and 2 lemons

Are there more oranges or more things to eat?

How many oranges?

How many lemons?

How many fruits?

Are there more oranges or more fruits? Why?

The relevant hints and leads are given to help the subject comprehend the various classes. Questions are repeated as often as it is found necessary, but the subjects are not told whether they are right or wrong in their responses.

GROUP II

Method: Self-discovery

Materials: Pictorial

Procedure

The objects for this task consist of pictorial representations of the animals, vegetables and fruits used in Group I. The subject is presented with pictures of these objects and the same questions are asked. The only difference between this group and the first group is the nature of the stimuli. No feedback is given to the subjects after their responses.

GROUP III

Method: Tutorial

Materials: Concrete

Procedure

The same procedure as for Group I is followed. The same questions are asked. The only difference between this group and the first group is that the subjects in this group receive feedback for their responses. The subjects are told when and why their responses are correct or incorrect.

Example of explanation

If the subject answers, "more sheep than animals", the experimenter says, "No, that's not correct". "You are supposed to say that there are more animals because horses are also animals". "Sheep, horses, pigs are all animals and so there are always more animals".

GROUP IV

Method: Tutorial

Materials: Pictorial

Procedure

The objects for this task consist of pictorial representations of the animals, vegetables and fruits used in Group I. The subject is presented with pictures of these objects and the same questions are asked. The subjects are given feedback for their responses and an explanation as for Group II is provided.

GROUP V

Materials: Verbal

Procedure

For this group, there are no visual aids used. The questions posed refer to the same objects as employed in Group I. As in the other groups, the aim is to make the subjects comprehend the logical operations $A + A' = B$; $A = B - A'$; and $A < B$.

The following questions are posed during training to help the subjects think about the various classes:

Animals:

1. Suppose a farmer has 5 brown sheep and 3 white sheep, does he have more brown sheep or more sheep? Why?
2. Does he have more brown sheep or more animals? Why?
3. If a farmer has 5 big pigs and 3 little pigs, does he have more big pigs or more pigs? Why?
4. Does he have more big pigs or more animals? Why?
5. If a farmer has 3 brown horses and 1 white horse, does he have more brown horses or more horses? Why?
6. Does he have more brown horses or more animals? Why?

7. Suppose a farmer has 5 brown sheep and 3 brown horses, does he have more sheep or more animals? Why?

Vegetables:

1. If you had 3 cobs of corn and 1 tomato, would you have more cobs of corn or more things to eat? Why?
2. Would you have more cobs of corn or more vegetables? Why?

Fruits:

1. If you had 3 bananas and 2 pineapples, would you have more bananas or more things to eat? Why?
2. Would you have more fruits or more bananas? Why?
3. If you had 3 apples and 2 pears, would you have more apples or more things to eat? Why?
4. Would you have more fruits or more apples? Why?
5. If you had 3 oranges and 2 lemons, would you have more oranges or more things to eat? Why?
6. Would you have more fruits or more oranges? Why?

APPENDIX C

POSTTESTS

IMMEDIATE TRANSFER TEST

Materials:

20 round wooden beads
18 brown and 2 white
1 sheet of green paper
2 boxes

Procedure

The subject is presented with a complete set of 20 wooden beads laid out in mixed order on a sheet of green paper. The subject is asked to pick up some of the beads and look at them. The following preliminary questions are asked:

a. What are these? ___________ b. What are the beads made of?___________ c. What colour are they? ___________ d. If I put the brown beads in this box, will there be any beads left? Yes ______ No ______ (Have the child perform the action if necessary)

Then the following class inclusion questions are asked:

(1) And if I put the wooden beads in the other box, will there be any beads left? Yes ______ No ______ (Have the child perform the action if necessary)

Why? ___________

(2) If I made a necklace with all the wooden beads and if I made a necklace of all the brown beads, which necklace would be longer?

Wooden necklace ___________ Brown necklace ___________

Why? ___________

(3) Are there more wooden beads or more brown beads?

More wooden beads ___________ More brown beads ___________

Why? ___________

This test was administered to all the subjects in the treatment groups as well as the control group.

TEN DAYS RETENTION TEST

Materials: (Concrete)

3 cobs of corn and 1 tomato

3 bananas and 2 pineapples

3 apples and 2 pears

3 oranges and 2 lemons

2 boxes

For the Pictorial Groups, these materials were pictorial representations of these same objects.

Procedure

The subject is presented with the above sets of fruits and vegetables laid out on the table. The subject is asked to examine the items. Then the following questions are asked:

3 cobs of corn and 1 tomato

(4) If I put all the cobs of corn in this box, will there be any vegetables left?

Yes _____ No _____ Why? ___________

(5) Are there more cobs of corn or more vegetables?

More cobs of corn ___________ More vegetables ___________

Why? ___________

3 bananas and 2 pineapples

(6) If you eat all the bananas and I eat all the fruits, who eats more?

Subject more ___________ Experimenter more ___________

Why? ___________

(7) Are there more fruits or more bananas?

More fruits ___________ More bananas ___________

Why? ___________

3 apples and 2 pears

(8) Who would have more to eat, someone who ate all the apples or someone who ate all the fruits?

Someone who ate all the apples ___________

Someone who ate all the fruits ___________

Why? ___________

(9) Are there more fruits or more apples?

More fruits ___________ More apples ___________

Why? ___________

3 oranges and 2 lemons

(10) What would you say if you wanted to eat the most:

"I'm going to eat all my oranges or I'm going to eat all my fruits?

I'm going to eat all my oranges ___________

I'm going to eat all my fruits ___________

Why? ___________

(11) Are there more fruits or more oranges?

More fruits ___________ More oranges ___________

Why? ___________

THREE WEEKS RETENTION TEST

Materials: The materials for this test were concrete or pictorial depending on the group.

5 brown sheep and 3 white sheep

(12) Are there more brown sheep or more sheep?

More brown sheep ___________ More sheep ___________

Why? ___________

(13) Are there more animals or more brown sheep?

More animals ___________ More brown sheep ___________

Why? ___________

5 big pigs and 3 little pigs

(14) Are there more big pigs or more pigs?

More big pigs ___________ More pigs ___________

Why? ___________

(15) Are there more animals or more big pigs?

More animals ___________ More big pigs ___________

Why? ___________

3 brown horses and 1 white horse

(16) Are there more brown horses or more horses?

More brown horses ___________ More horses ___________

Why? ___________

(17) Are there more animals or more brown horses?

More animals ___________ More brown horses ___________

Why? ___________

5 brown sheep and 3 brown horses

(18) Are there more animals or more brown sheep?

More animals ________ More brown sheep ________

Why ? ________

ONE MONTH TRANSFER TEST

4 white toy cows and 1 brown cow, all sitting on their stomachs

(19) Are there more white cows or more sitting cows?

More white cows ________ More sitting cows ________

Why? ________

4 white toy cows and 1 brown cow laid on their sides

(20) Are there more white cows or more sleeping cows?

More white cows ________ More sleeping cows ________

Why? ________

5 toy cows and 2 toy goats

(21) Are there more cows or more animals?

More cows ________ More animals ________

Why? ________

(22) Would a farmer need more grass for the cows or for the animals?

More for the cows ________ More for the animals ________

Why? ________

(23) In the whole world, are there more animals or more cows?

More animals ________ More cows ________

Why? ________

(24) Who would need a bigger shed, a farmer who owned all the cows or a farmer who owned all the animals?

Farmer who owned all the cows ___________

Farmer who owned all the animals ___________

Why? ___________

The questions in this Test were administered to all the subjects in the treatment groups including the control group. For the subjects in the Verbal Group, the questions in the Ten Days and Three Weeks Retention Tests were worded differently as follows:

TEN DAYS RETENTION TEST

Materials: Verbal

(4) If you had 3 cobs of corn and 1 tomato, would you have more cobs of corn or more things to eat?

More cobs of corn ___________ More things to eat ___________

Why? ___________

(5) Would you have more vegetables or more cobs of corn?

More vegetables ___________ More cobs of corn ___________

Why? ___________

(6) Suppose your friend had 3 bananas and 2 pineapples, would he have more bananas or more things to eat?

More bananas ___________ More things to eat ___________

Why? ___________

(7) Would he have more fruits or more bananas?

More fruits ___________ More bananas ___________

Why? ___________

(8) Suppose another friend of yours had 3 apples and 2 pears, would she have more apples or more things to eat?

More apples __________ More things to eat __________

Why? __________

(9) Would she have more fruits or more apples?

More fruits __________ More apples __________

Why? __________

(10) If you had 3 oranges and 2 lemons, would you have more oranges or more things to eat?

More oranges __________ More things to eat __________

Why? __________

(11) Would you have more fruits or more oranges?

More fruits __________ More oranges __________

Why? __________

THREE WEEKS RETENTION TEST

(12) Suppose a farmer has 5 brown sheep and 3 white sheep, does he have more brown sheep or more sheep?

More brown sheep __________ More sheep __________

Why? __________

(13) Does he have more animals or more brown sheep?

More animals __________ More brown sheep __________

Why? __________

(14) If a farmer has 5 big pigs and 3 little pigs, does he have more big pigs or more pigs?

More big pigs __________ More pigs __________

Why? __________

(15) Does he have more animals or more big pigs?

More animals ___________ More big pigs ___________

Why? ___________

(16) If a farmer has 3 brown horses and 1 white horse, does he have more brown horses or more horses?

More brown horses ___________ More horses ___________

Why? ___________

(17) Does he have more animals or more brown horses?

More animals ___________ More brown horses ___________

Why? ___________

(18) Suppose a farmer has 5 brown sheep and 3 brown horses, does he have more animals or more brown sheep?

More animals ___________ More brown sheep ___________

Why? ___________

APPENDIX D

SPLIT OF ITEM DIFFICULTIES: "ABSTRACT" and "CLOSE-TO-EVERYDAY-EXPERIENCE

	MEANS<10	"ABSTRACT"		MEANS>10	"CLOSE-TO-EVERYDAY-EXPERIENCE"
ITEMS	MEANS	TEST 1	ITEMS	MEANS	TEST 2
3	8.0	More wooden beads or more brown beads?	1	12.1	If I put wooden beads in box will there be any beads left?
			2	10.9	If I made necklace of wooden beads and necklace of brown beads, which would be longer?
		TEST 3			TEST 4
5	7.8	More cobs of corn or more vegetables?	4	14.5	If all cobs of corn in box, will there be any vegetables left?
7	8.3	More fruits or more bananas?	6	11.6	If you eat all bananas and I eat all fruits, who eats more?
9	8.2	More fruits or more apples?			
11	8.2	More fruits or more oranges?	8	12.3	Who has more to eat, one who ate all apples or one who ate all fruits?
			10	11.9	I'm going to eat all my oranges or I'm going to eat all my fruits?
		TEST 5			TEST 6
13	8.1	More animals or more brown sheep?	12	14.9	More brown sheep or more sheep?
15	8.4	More animals or more big pigs?	14	14.9	More big pigs or more pigs?
17	8.6	More animals or more brown horses?	16	15.2	More brown horses or more horses?
			18	10.2	More animals or more brown sheep?
		TEST 7			TEST 8
21	7.8	More cows or more animals?	19	14.6	More white cows or more sitting cows?
22	9.3	Need more grass for cows or for animals?	20	14.8	More white cows or more sleeping cows?
23	9.1	In whole world, more animals or more cows?			
24	8.1	Bigger shed for all cows or for all animals?			

APPENDIX E

SCORING CATEGORIES

In presenting the posttests, the interest was to find out whether the subjects would retain and transfer their understanding of inclusive relations, such as cows being part of a larger more inclusive category of animals or apples being part of a larger more inclusive category of fruits etc. as provided during the training sessions.

Since the Posttests were composed of different numbers of items, the following criteria were used for scoring the items in each Test to produce a:

a. Full Score
b. Partial Score
c. No Score

In TEST 1, a Full Score means a correct response with a correct explanation. Partial Score means a correct response with an incomplete or inappropriate explanation. No Score means an incorrect response.

In TEST 2, a Full Score means 2 correct responses with correct explanations. Partial Score means 1 correct response with a correct explanation. No Score means 0 (Zero) correct responses.

In TEST 3, a Full Score means 4 correct responses with correct explanations. Partial Score means 2 or 3 correct responses with correct explanations. No Score means 1 or 0 correct responses.

In TEST 4, a Full Score means 4 correct responses with correct explanations. Partial Score means 2 or 3 correct responses with correct explanations. No Score means 1 or 0 correct responses.

In TEST 5, a Full Score means 3 correct responses with correct explanations. Partial Score means 2 correct responses with correct explanations. No Score means 1 or 0 correct responses.

In TEST 6, a Full Score means 4 correct responses with correct explanations. Partial Score means 2 or 3 responses correct with correct explanations. No Score means 1 or 0 correct responses.

In TEST 7, a Full Score means 4 correct responses with correct explanations. Partial Score means 2 or 3 correct responses with correct explanations. No Score means 1 or 0 correct responses.

In TEST 8, a Full Score means 2 correct responses with correct explanations. Partial Score means 1 correct correct response with a correct explanation. No Score means 0 (Zero) correct responses.

Meaning of Scoring Categories

Full Understanding of Class Inclusion

The subject consistently indicates understanding that the superordinate class (e.g. fruits) is always larger than one of its constituent subclasses (e.g. apples). For instance, in Test 4, items 6, 8, and 10, the subject should be able to indicate comprehension of the fact that the "Eat-More-Fruit" condition always means that the two subclasses (bananas and pineapples) are combined to form the larger superordinate class (fruits). This means that the person who gets "more fruits" always eats more than the person who gets any of the larger subclasses.

For explanation, the subject should be able to show understanding that the larger subclass (bananas) also belongs to the general, more inclusive class of (fruits).

For example: "There are more fruits than bananas
because pineapples are also fruits".

Partial Understanding of Class Inclusion

The subject should be able to indicate some understanding that the superordinate class (fruits) is always larger than one of its constituent subclasses (apples), but may not give an adequate explanation for the basis he uses to include one class in the other. In some cases the subject may shift the criterion he uses to explain his response.

For example: "There are more fruits than apples
because you see all kinds of fruits
in stores".

No Understanding of Class Inclusion

The subject consistently shows lack of any understanding that the superordinate class (fruits) is always larger than one of its constituent subclasses (apples). The subject responds but has no observable consistent basis for including one class in the other and gives inadequate explanations for his sometimes, random responses.

For example: "There are more apples than fruits because
there's a whole bunch of them in Safeway".

APPENDIX F

SCORING WITHOUT JUSTIFICATION

The Ten Days Retention Test and the One Month Transfer Test were used for scoring without justification. These Tests were selected on the basis of the time duration between them and the fact that they are more likely to be used in Phase II of this study.

The scoring categories were as follows:

TEST 3: Full Score - 4 correct responses
Partial Score - 2 or 3 correct responses
No Score - 1 or 0 correct responses

TEST 4: Full Score - 4 correct responses
Partial Score - 2 or 3 correct responses
No Score - 1 or 0 correct responses

TEST 7: Full Score - 4 correct responses
Partial Score - 2 or 3 correct responses
No Score - 1 or 0 correct responses

TEST 8: Full Score - 2 correct responses
Partial Score - 1 correct response
No Score - 0 correct responses

The meaning of these scoring categories is the same as that provided in Appendix E except that the justification requirement does not apply here.

APPENDIX G

IDEAS ON REPLICATION

This study was designed with the expectation that it could be replicated in a future study within a culture which may be different from the North American way of life. Some suggestions are given here as to how parts of the present study could be modified so as to accommodate the situations prevailing in a different culture.

The present study did not strictly find any significant differences between subjects trained using various materials although subjects in concrete training groups were always on the lead. This finding provides an important direction for future research. For the Kikuyu (Kenya) sample of Phase II of this study, it can be expected that subjects will perform at a higher level with concrete materials than with pictorial or verbal materials. This expectation is given from knowledge and experience in the culture, where children are brought up and taught to interact with concrete and real life objects. Thus the children may know from experience what corn is but may fail to recognize it in a picture.

It would therefore, be inappropriate to use pictorial materials especially in a rural environment with unschooled children, because such children may not adequately have been exposed and shown how to reason with such materials. Pictures may not help children construct knowledge of objects since a child cannot come to know what a cow or a pineapple is from a picture, except in a very limited sense. This is simply because a picture is a static representation which reveals only what a single case of the class of objects looks like. In general the dynamic and generalizable qualities of objects cannot be learned through nonexperiential methods among children at the preoperational level.

The subjects in the present study were required to justify the responses they made. The second phase of the study will not lay much emphasis on the justification question, because it has been found to be inappropriate in cross-cultural settings. One reason for this lies in the fact that the requisite ability to verbalize reasons for one's judgment varies from culture to culture. Among the children from the culture of Phase II of this study, emphasis is put on the observational characteristics of what is to be learned without necessarily promoting verbal formulations of the material. It is taken as criticism when a child is asked to explain or justify a response he has made. An assumption is made to the effect that the initial response must be wrong and therefore, a new response is required. In such cases the child is more likely to change his mind and give a totally different response or simply keep quiet. Recent cross-cultural investigations, (Bovet, 1974; Dasen, 1974; Kiminyo, 1973; Irvine, 1978) have found the requirement for the justification question undesirable in cross-cultural research.

For the second phase of the study, particular emphasis will be put on the use of materials that are local, indigenous and therefore, familiar to the subjects. Various kinds of trees, sticks and leaves can be used instead of coloured circles and square blocks. Counting and classifying can be done with real life animals (goats, sheep, cows) fruits (bananas and other local fruits with none-translatable names) or vegetables (maize, yams, cassava, sweet potatoes etc.). The use of unfamiliar objects has been found to produce very biased results in cross-cultural studies. Some concerned investigators have noted that it is no longer useful for western experimenters to employ materials that are categorizable to them and ask whether subjects from other cultures use the same kind of classification system. The basic point here is that the use of a classification system determined from "outside" the culture of the subjects confounds ability to classify with ability to use arbitrary and unnatural systems of classification. What might be of use is to find out what systems of classification are naturally employed within the culture. (Cole et al, 1971).

Although conclusions can be drawn about a child's capabilities from his successful or unsuccessful performance, it may be wrong to infer the child's underlying incompetence from his failure to perform. Instead of collecting data through standardized performance tests, investigators should go beyond that and use the clinical procedures which have been shown to help uncover the competence underlying the performance. This will be the method of the second phase of the study because the writer is of the opinion that it is wrong to assume that the underlying competence is lacking, simply because a subject has failed to give the desired performance. It should be the responsibility of the investigator to assist the child in expressing the competence he has through training and with the use of a variety of materials.

To establish and maintain rapport, the use of a language that the child understands and in which he can communicate his responses is an added advantage which makes the child much more confident in what he says and does during the testing situation.

In more general terms, an awareness of cross-cultural differences in classification and other Piagetian concepts may serve as the starting point for those cross-cultural studies that are to be methodologically defensible.

On the basis of this awareness, researchers must make an important decision about the general approach of their research and should therefore, look not only for cultural differences but for cultural similarities as well. This stems from the assumption that cognitive processes are universal whereas cognitive content varies according to cultural values and norms. Consequently, if comparisons are to be legitimately made across cultural boundaries, it is first necessary to establish equivalent bases upon which to make such comparisons (Berry, 1969). Such comparisons should also focus on the presence or absence of meanings that individuals attach to specific stimuli such as test items or certain words in psychological experiments.

A cross-cultural comparison would therefore, demand some distinction between what a person can learn to do and what he is disposed to do naturally within a particular cognitive domain.